VAISALA

USER'S GUIDE

Vaisala HUMICAP® Humidity and Temperature Transmitter Series HMT360

M010056EN-J

PUBLISHED BY

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CHAPTER 1
GENERAL INFORMATION

This chapter provides general notes for the manual and the product.

About This Manual

This manual provides information for installing, operating, and maintaining the Vaisala HUMICAP® Humidity and Temperature Transmitter Series HMT360.

Contents of This Manual

- Chapter 1, General Information: This chapter provides general notes for the manual and the product.
- Chapter 2, Product Overview: This chapter introduces the features, advantages, and the product nomenclature.
- Chapter 3, Installation: This chapter provides you with information that is intended to help you install this product.
- Chapter 4, Operation: This chapter contains information that is needed to operate this product.
- Chapter 5, Measuring at Overpressure: This chapter provides you with important information concerning measurement in conditions with pressure higher than the normal atmospheric pressure.
- Chapter 6, Calibration and Adjustment: This chapter contains instructions for checking the calibration and adjusting this product.
- Chapter 7, Maintenance: This chapter provides information that is needed in basic maintenance of the product.
- Chapter 8, Troubleshooting: This chapter describes common problems, their probable causes and remedies, and contact information.

- Chapter 9, Technical Data: This chapter provides technical data of the product.
- Appendix A, Dimensions: This appendix contains parts drawings of the transmitter housing, probes and some transmitter mounting accessories with metric and nonmetric dimensions specified.
- Appendix B, Wiring for Intrinsically Safe Operation, FM: This appendix contains the wiring diagram for intrinsically safe operation approved by Factory Mutual (FM).
- Appendix C, Wiring for Intrinsically Safe Operation, CSA: This appendix contains the wiring diagram for intrinsically safe operation approved by the Canadian Standards Association (CSA).

Version Information

Table 1 Manual Revisions

Manual Code	Description
M010056EN-J	This manual. November 2013. - Removed Appedix D, Certificates. Copies of certificates are included in HMT360 Safety Guide from version M210483EN-E onward. - Added table of error codes, see Table 7 on page 74. - Updated section Options and Accessories on page 81.
M010056EN-I	Previous version.

Related Manuals

Table 2 Related Manuals

Manual Code	Manual Name
M210185EN	Humidity Calibrator HMK15 User's Guide
M210483EN	Vaisala Transmitter Series HMT360 Safety Guide

Documentation Conventions

Throughout the manual, important safety considerations are highlighted as follows:

WARNING	Warning alerts you to a serious hazard. If you do not read and follow instructions very carefully at this point, there is a risk of injury or even death.

CAUTION	Caution warns you of a potential hazard. If you do not read and follow instructions carefully at this point, the product could be damaged or important data could be lost.

NOTE	Note highlights important information on using the product.

Safety

The HMT360 series transmitter delivered to you has been tested for safety and approved as shipped from the factory. Note the following precautions:

WARNING	Ground the product, and verify outdoor installation grounding periodically to minimize shock hazard.

CAUTION	Do not modify the unit. Improper modification can damage the product or lead to malfunction.

ESD Protection

Electrostatic Discharge (ESD) can cause immediate or latent damage to electronic circuits. Vaisala products are adequately protected against ESD for their intended use. However, it is possible to damage the product by delivering electrostatic discharges when touching, removing, or inserting any objects inside the equipment housing.

To make sure you are not delivering high static voltages yourself:

- Handle ESD sensitive components on a properly grounded and protected ESD workbench.
- When an ESD workbench is not available, ground yourself to the equipment chassis with a wrist strap and a resistive connection cord.
- If you are unable to take either of the above precautions, touch a conductive part of the equipment chassis with your other hand before touching ESD sensitive components.
- Always hold component boards by the edges and avoid touching the component contacts.

Recycling

Recycle all applicable material.

Dispose of batteries and the unit according to statutory regulations. Do not dispose of with regular household refuse.

Regulatory Compliances

EU Declaration of Conformity

The HMT360 series transmitters are in conformity with the provisions of the following EU directive(s):

- ATEX Directive
- EMC Directive
- ROHS Directive

Conformity is shown by compliance with the following standards:

- EN 60079-0
- EN 60079-11
- EN 60079-26
- EN 61326-1: Electrical equipment for measurement, control and laboratory use - EMC requirements - for use in industrial locations.
- EN 55022: Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement.

Certifications

The certifications that have been granted to the HMT360 series, and the accompanying safety factors, are listed in section Classification with Current Outputs on page 79.

Copies of the certificates and wiring diagrams are provided in the HMT360 Safety Guide (from version M210483EN-E onward). You can download updated certificates from the HMT360 product page at the Vaisala website: www.vaisala.com/hmt360.

Trademarks

HUMICAP® is a registered trademark of Vaisala Oyj.

All other trademarks are the property of their respective owners.

Software License

This product contains software developed by Vaisala. Use of the software is governed by license terms and conditions included in the applicable supply contract or, in the absence of separate license terms and conditions, by the General License Conditions of Vaisala Group.

Warranty

Visit our Internet pages for more information and our standard warranty terms and conditions: www.vaisala.com/warranty.

Please observe that any such warranty may not be valid in case of damage due to normal wear and tear, exceptional operating conditions, negligent handling or installation, or unauthorized modifications. Please see the applicable supply contract or Conditions of Sale for details of the warranty for each product.

CHAPTER 2

PRODUCT OVERVIEW

This chapter introduces the features, advantages, and the product nomenclature.

Introduction to HMT360

Vaisala HUMICAP® Humidity and Temperature Transmitter Series HMT360 contains reliable, microprosessor-based two-wire instruments for measuring relative humidity and temperature in hazardous areas.

Figure 1 HMT360 and Probe Types

WARNING In hazardous environments, the transmitters must always be connected via galvanic isolators or Zener barriers.

Output Quantities

Vaisala HUMICAP® Humidity and Temperature Transmitter Series HMT360 is available either with or without a local display and with one or two current output channels.

Available output quantities are listed in the table below:

Table 3 Output Quantities for HMT360

Character	Quantity	Abbreviation	Availability
0	relative humidity	RH	A, D
1	temperature	T	A, D, F, H
2	dewpoint temperature	Td	D
3	absolute humidity	a	D
4	mixing ratio	x	D
5	wet bulb temperature	Tw	D
6	mass concentration of water	ppmw	H
7	water activity	aw	H, F
8	relative humidity of saturation	RS	H
9	saturation temperature	Ts	H

The characters used to indicate availability in the table above:

A = Available for HMT360 standard version

D = Available for HMT360 with optional calculations

F = Available for HMT360 Moisture and Temperature in oil transmitter

H = Available for HMT360 Moisture and Temperature in Jet Fuel transmitter

Probe Options

The HMT360 series has various options for probes and cable lengths (2 m, 5 m and 10 m). The available probe types are presented in the figure below.

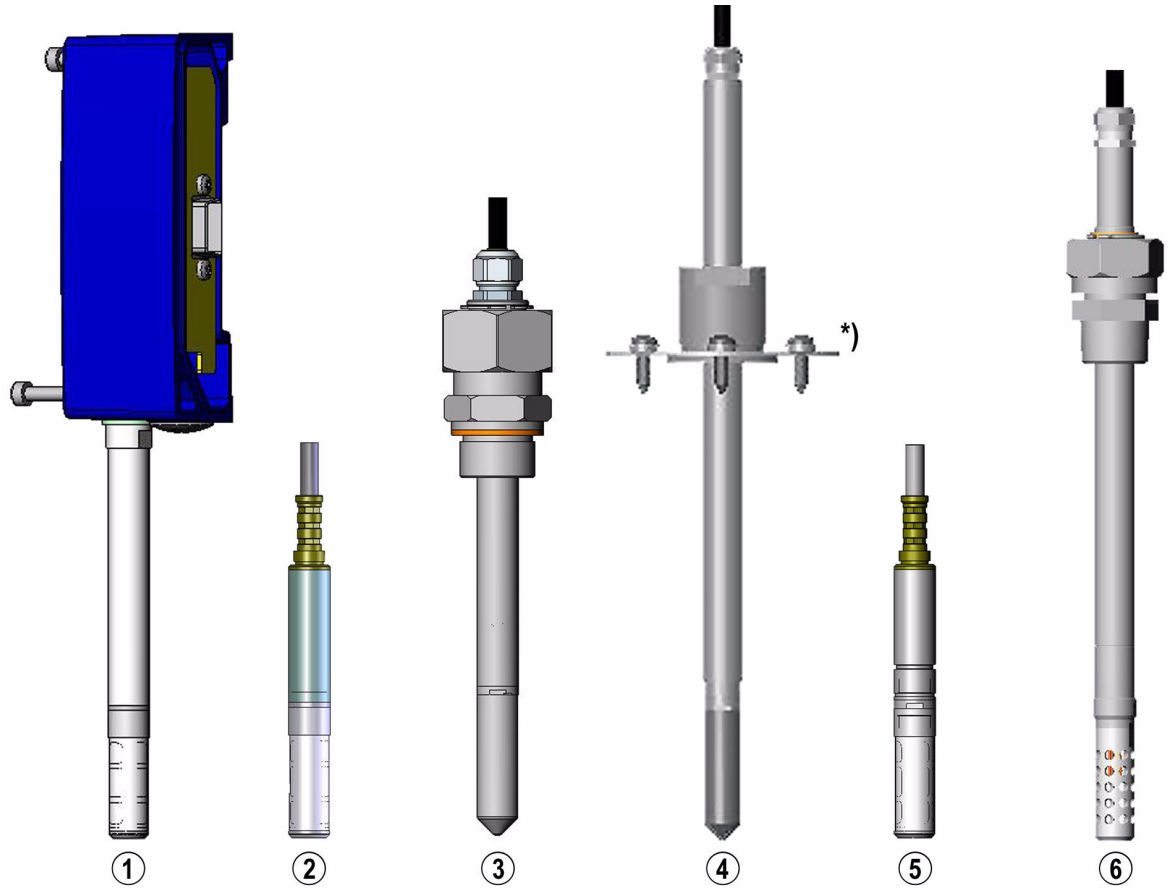


Figure 2 Probe Options for HMT360

The following numbers refer to Figure 2 on page 17:

1 = HMP361 probe for wall mounting

2 = HMP363 probe for tight spaces

3 = HMP364 probe for pressurized spaces up to 100 bars

4 = HMP365 probe for high temperatures up to 180 °C *) Flange for HMP365 available as an option

5 = HMP367 probe for high humidities

6 = HMP368 probe for installations in pressurized pipelines up to 40 bars; features a pressure-tight sliding clasp nut

CHAPTER 3

INSTALLATION

This chapter provides you with information that is intended to help you install this product.

General Installation Instructions

Mounting the Probe Cable in Gas Group IIC Spaces

NOTE	The following applies only to installation within the EU! The following instructions shall be followed to fulfil the specifications of the EN50284 for nonconductive layer of the probe cable: - Never mount or handle the probe cable when hazardous gases are present. - For achieving a conductive shield, cover the probe cable with conductive material like metal or conductive tape or mount the probe cable in a metal conduit. - Assure that the conductive shield fulfils requirements of the standard EN50284 (resistance less than 1 GΩ) and make sure that it can not come loose in any operation situation.

WARNING	During the installation work of the probes in gas group IIC areas (requiring category I devices), it has to be guaranteed that even in fault cases sparks generated by impacts or friction on the surface of the housing can never occur.

Selecting Location

Select a place with stable conditions for mounting the transmitter. Do not expose the transmitter to direct sunlight or rain. A rain shield is available and it is recommended for direct outdoor installations. When mounting the probe, select a place representing the process conditions.

General Instructions for Probes with Cable

Mount the probes with a cable horizontally; this way, any water condensing on the tube cannot flow onto the sensor.

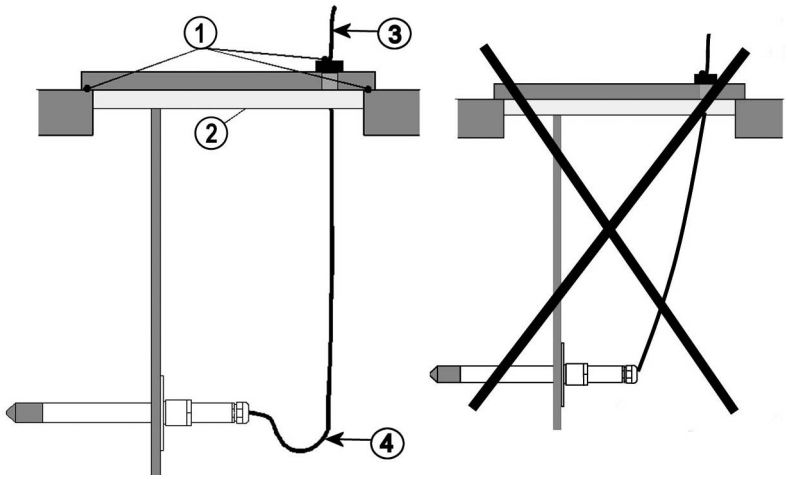


Figure 3 Horizontal Mounting of Probe

The following numbers refer to Figure 3 on page 20:

1 = To be sealed

2 = To be insulated

3 = Insulate the cable

4 = Let the cable hang loosely. This prevents condensed water running to the sensor along the cable.

When there is no alternative but to install the probe in the process vertically, the point of entry must be carefully insulated. The cable must also be allowed to hang loosely as this prevents any condensed water from running onto the probe along the cable.

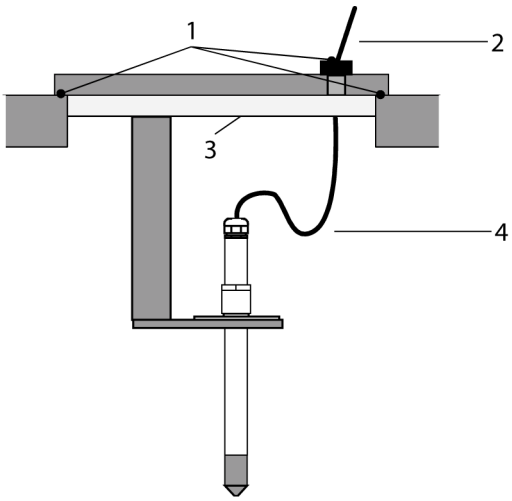


Figure 4 Vertical Mounting of Probe

The following numbers refer to Figure 4 on page 21:

1 = To be sealed

2 = Insulate the cable

3 = To be insulated

4 = Let the cable hang loosely. This prevents condensed water running to the sensor along the cable

If the process temperature is much higher than that of the environment, the whole probe and preferably plenty of cable must be inside the process. This prevents measuring inaccuracy caused by heat conduction along the cable.

When mounted on the side of a duct or channel, the probe must be inserted from the side of the duct. If this is not possible and the probe must be inserted from the top, the point of entry must be carefully insulated.

For Vaisala probe installation kits and some installation examples see section Probe Mounting on page 24.

Checking the Temperature Reading

The actual temperature of the process can be measured with a reference instrument to be compared with the transmitter reading. The heat transfer is less evident if you remove the protective filter of the sensor for a short-term test. However, never use the sensor long periods without the filter as this may cause a faster contamination of the sensor. The transmitter fulfils the specified EMC regulations with the protective filter on the probe.

In humidity measurement and especially in calibration and adjustment it is essential that temperature of the probe and measuring environment is the same. Even a small difference in temperature between the environment and the probe causes an error. As the curve below shows, if the temperature is +20 °C and the relative humidity 100 %RH, a difference of ±1 °C between the environment and the probe causes an error of ±6 %RH.

The graph below illustrates the measurement error at 100 %RH when the difference between the ambient and sensor temperature is 1 °C.

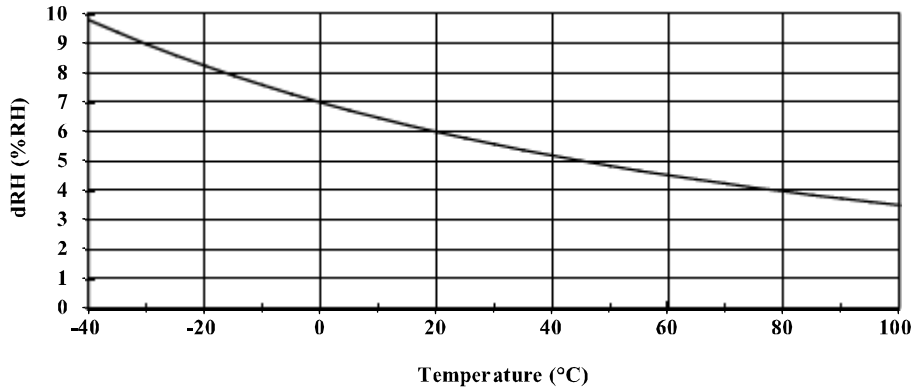


Figure 5 Measurement Error at 100 %RH

Mounting the Transmitter Housing

1. Attach the mounting plate to the wall with 4 screws.
2. Press down the transmitter so that it slides along the rails of the mounting plate.
3. Fasten the transmitter to the mounting plate with the Allen screw (3 mm Allen key provided).

The probe can be detached and replaced when needed by simply unfastening the two Allen screws.

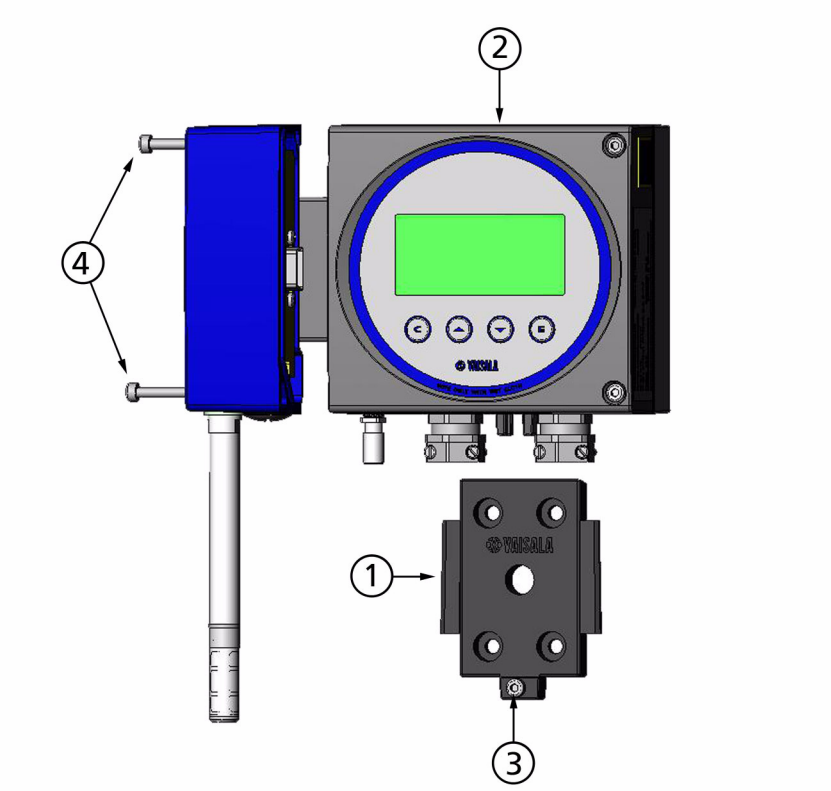


Figure 6 Transmitter Mounting

The following numbers refer to Figure 6 on page 23:

1 = Mounting plate

2 = Transmitter housing

3 = Allen screw

4 = Allen screws

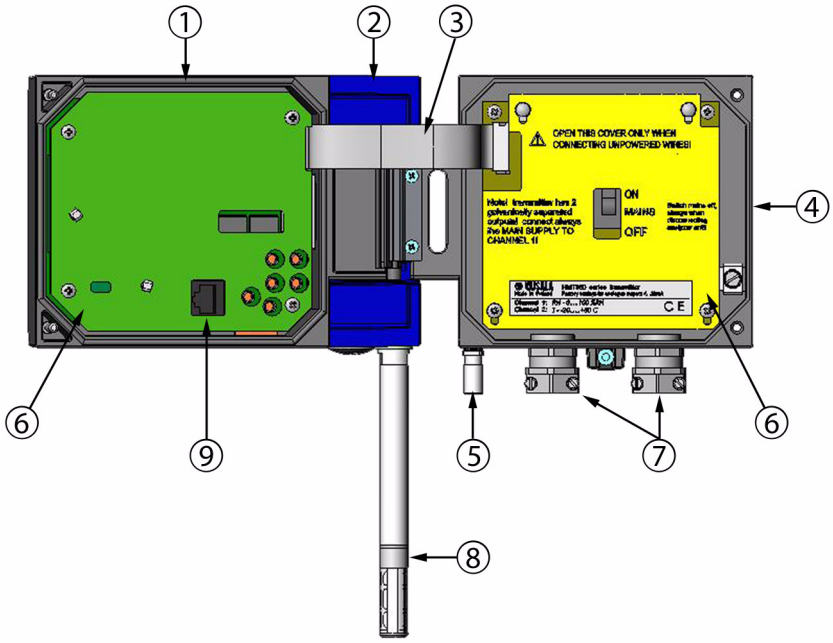


Figure 7 Parts of the Transmitter

The following numbers refer to Figure 7 on page 24:

1 = Electronics unit

2 = Probe; including a part of the measurement electronics (for example, calibration memory)

3 = Flat cable

4 = Transmitter base

5 = Grounding terminal

6 = Protective covers

7 = Cable glands

8 = Probe

9 = RS232C connector

Probe Mounting

CAUTION Do not unsolder and then resolder the probe cable from and to the printed board during installation.

Do not shorten or lengthen the probe cable.

These procedures may alter the humidity calibration of the transmitter.

HMP363 for Confined Spaces

The HMP363 is a small size (ø = 12mm) general-purpose probe suitable for ducts and channels with the installation kit available from Vaisala.

The HMP363 provides for two measuring range options. The first probe version is equipped with a flexible cable and can be used when measuring in environments up to 80 ºC. The second version is suitable for measuring in environments up to 120 ºC.

Section HMP363/365/367 Duct Installation Kit on page 25 shows mounting of HMP363/367 with the optional duct installation kit.

HMP363/365/367 Duct Installation Kit

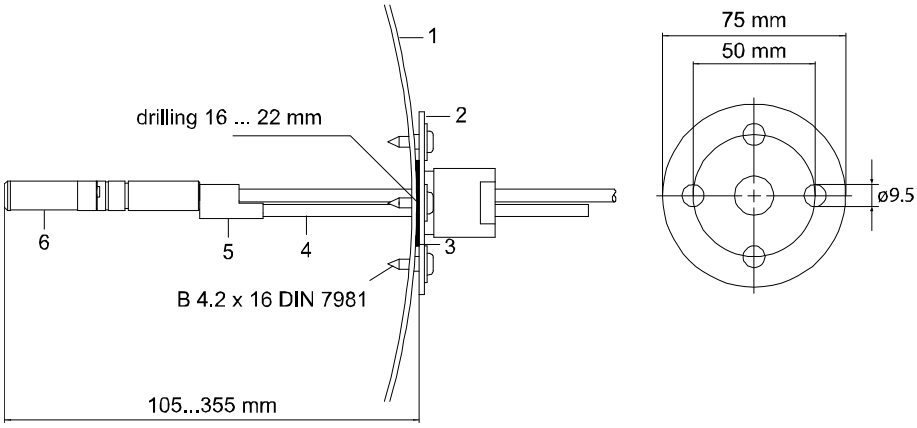


Figure 8 Installation of HMP363 Probe in Duct with Flange and Supporting Bar

The following numbers refer to Figure 8 on page 25:

1 = Duct wall

2 = Flange

3 = Sealing ring

4 = Supporting bar

5 = Probe attaching part (to be fixed with supporting bar)

6 = RH probe

HMP364 for High-Pressure Applications

The probe is provided with a nut, a fitting screw and a sealing washer. Keep the fitting screw and the nut in place on the body of the probe during handling to prevent damage to the highly polished surface of the probe. Follow the instructions below to achieve a leak-tight assembly.

CAUTION In pressurized processes it is essential to tighten the supporting nuts and screws very carefully to prevent loosening of the probe by the action of pressure.

1. Remove the fitting screw from the nut and the probe.
2. Fasten the fitting screw to the chamber wall with a sealing washer. Tighten the fitting screw into the threaded sleeve with a torque spanner. The tightening torque is 150 ± 10 Nm (110 ± 7 ft-lbs).
3. Insert the body of the probe into the fitting screw and tighten the nut manually to the fitting screw.
4. Mark both the fitting screw and the nut hex.
5. Tighten the nut a further 30º (1/12) turn or if you have a torque spanner tighten it with a torque of 80 ± 10 Nm (60 ± 7 ft-lbs).
6. Clean and grease the tightening cone of the fitting screw after every tenth detachment. Change the sealing washer every time the fitting screw is detached. Use high-vacuum grease, for example Dow Corning, or a similar grease.

NOTE When retightening the nut after detachment the nut must be tightened without increased effort.

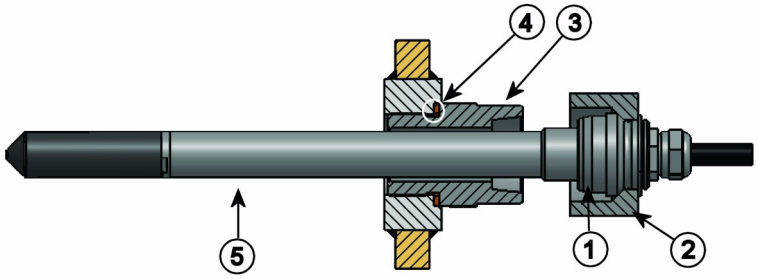


Figure 9 HMP364 Probe Mounting

The following numbers refer to Figure 9 on page 27:

1 = Tightening cone

2 = Nut

3 = Fitting screw, M22×1.5 or NPT 1/2"

4 = Sealing washer

5 = Probe; ø12 mm

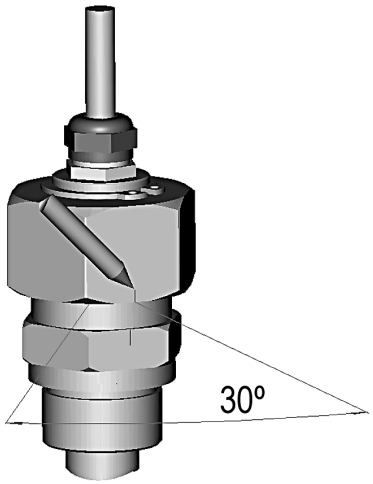


Figure 10 Marking Nut and Fitting Screw

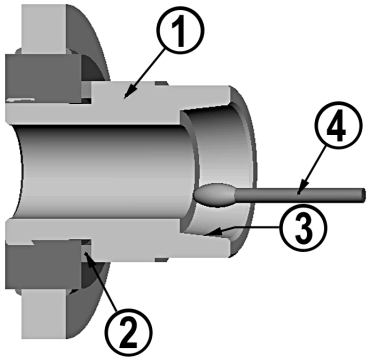


Figure 11 Cleaning the Tightening Cone

The following numbers refer to Figure 11 on page 28:

1 = Fitting screw

2 = Sealing washer

3 = Tightening cone

4 = Clean cotton stick

CAUTION	In pressurized processes it is essential to tighten the supporting nuts and screws very carefully to prevent loosening of the probe by the action of pressure.

NOTE	When HMP364 is installed in a process with a pressure differing from normal atmospheric pressure, please enter the pressure value of the process (in bar_a) into the transmitter memory, see sections PRES Setting Ambient Pressure for Calculations on page 56 and Setting the Pressure for Calculations on page 46.

HMP365 for High Temperatures

HMP365 is installed similarly to the HMP363 probe but without the supporting bar. Refer to HMP363/365/367 Duct Installation Kit on page 25 for more information on the duct installation kit for HMP365.

To avoid incorrect humidity readings, there must not be significant temperature differences between the inside and outside of the duct.

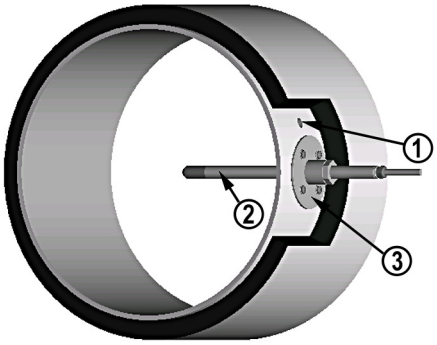


Figure 12 Mounting HMP365 Probe in Duct or Channel

The following numbers refer to Figure 12 on page 29:

1 = A plugged hole for reference measurements

2 = Probe

3 = Mounting flange

HMP367 for High Humidities

The HMP367 is for environment where relative humidity is very high, near saturation.

Section HMP363/365/367 Duct Installation Kit on page 25 shows mounting of HMP363/367 with the optional duct installation kit.

HMP368 for Pressurized Pipelines or Moisture in Liquids

Due to the sliding fit the HMP368 is easy to install into and remove from a pressurized process. The probe is especially suitable for measurements inside pipelines. See section Installing the HMP368 Probe Through a Ball Valve Assembly on page 32.

CAUTION In pressurized processes it is essential to tighten the supporting nuts and screws very carefully to prevent loosening of the probe by the action of pressure.

NOTE When HMP368 is installed in a process with a pressure differing from normal atmospheric pressure, please enter the pressure value of the process (in bar_a) into the transmitter memory. See sections PRES Setting Ambient Pressure for Calculations on page 56 and Setting the Pressure for Calculations on page 46.

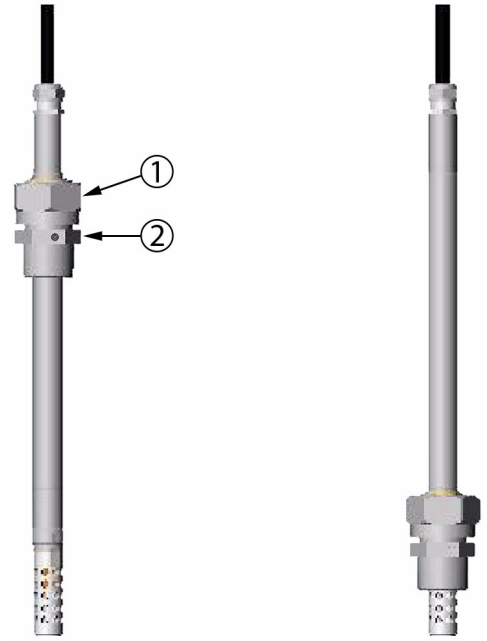


Figure 13 HMP368 Probe

The following numbers refer to Figure 13 on page 30:

1 = Clasp nut, 24 mm hex nut

2 = Fitting body, 27 mm hex nut

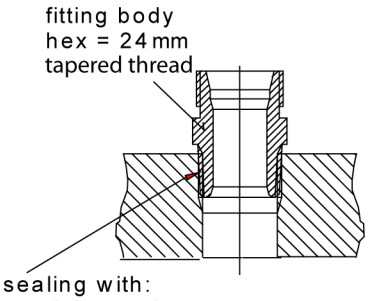
The following two fitting body options are available:

- Fitting Body ISO1/2 solid structure
- Fitting Body NPT1/2 solid structure

Table 4 HMP368 Probe Dimensions

Probe Type	Probe Length	Adjustment Range
Standard	178 mm	120 mm
Optional	400 mm	340 mm

CAUTION Take care not to damage the probe body. A damaged body makes the probe head less tight and may prevent it from going through the clasp nut.



sealing with:
1. LOCTITE® No 542 + activ. No 7649 (t=-55...+150 °C)
2. MEGA-PIPE EXTRA No 7188 (t=-55...+170 °C)
3. PTFE tape (t=-60...+210 °C) NOTE: the tape does not lock the parts together. Therefore, use two fork spanners (hex 24 and 27 mm) for tightening and opening the clasp nut of the probe

Figure 14 Sealing of Fitting Body into Process

Tightening the Clasp Nut

1. Adjust the probe to a suitable depth according to the type of installation.
2. Tighten the clasp nut first manually.
3. Mark the fitting screw and the clasp nut.
4. Tighten the nut a further 50 ... 60° (ca. 1/6 turn) with a fork spanner. If you have a suitable torque spanner, tighten the nut to 45 ± 5 Nm (33 ± 4 ft-lbs).

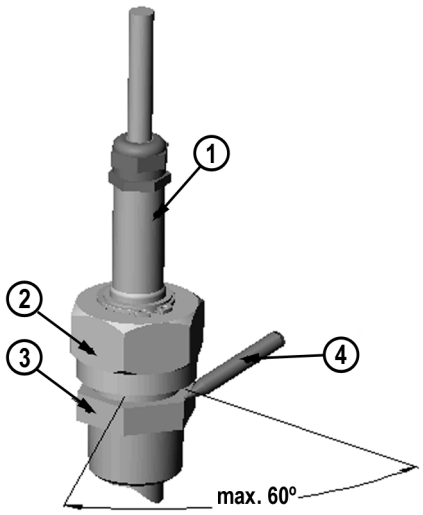


Figure 15 Tightening the Clasp Nut

The following numbers refer to Figure 15 on page 32:

1 = Probe

2 = Clasp nut

3 = Fitting screw

4 = Pen

NOTE Take care not to tighten the clasp nut more than 60° to avoid difficulties when opening it.

Installing the HMP368 Probe Through a Ball Valve Assembly

The ball valve installation kit (Vaisala order code: BALLVALVE-1) is preferred when connecting the probe to a pressurized process or pipeline. Use the ball valve set or a 1/2" ball valve assembly with a ball hole of ø14 mm or more. If you install the probe (ø12 mm) in a process pipe, please note that the nominal size of the pipe must be at least 1 inch (2.54 cm). Use the manual press handle to press the probe into the pressurized (< 10 bar) process or pipeline.

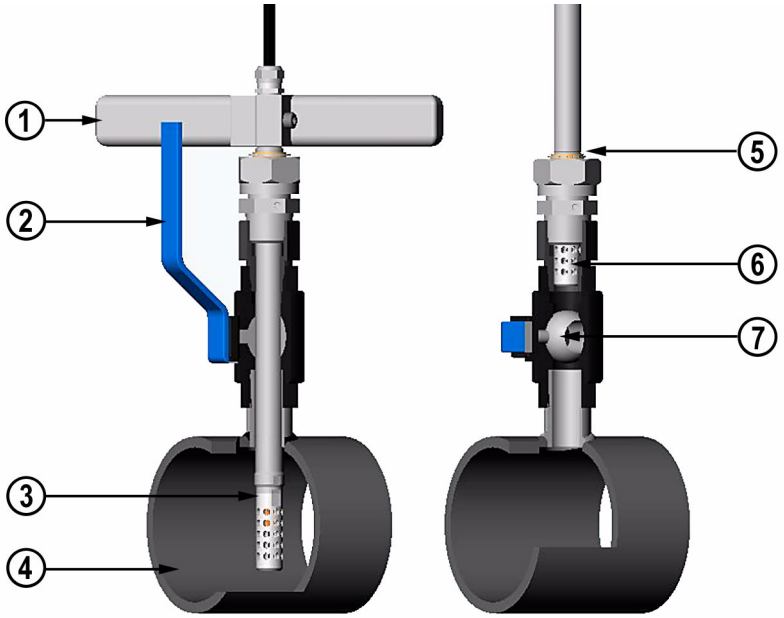


Figure 16 Installing the HMP368 Probe Through a Ball Valve Assembly

The numbers below refer to Figure 16 on page 33:

1 = Manual press tool

2 = Handle of the ball valve

3 = Probe

4 = Process chamber/pipeline

5 = Groove on the probe indicating the upper adjustment limit

6 = Filter

7 = Ball of the ball valve

NOTE The probe can be installed in the process through the ball valve assembly provided that the process pressure is less than 10 bar. This way, the process does not have to be shut down when installing or removing the probe. However, if the process is shut down before removing the probe, the process pressure can be max. 20 bar.

NOTE When measuring temperature dependent quantities make sure that the temperature at the measurement point is equal to that of the process, otherwise the moisture reading may be incorrect.

Follow the steps below to install the HMP368 probe through a ball valve assembly. After the installation, the probe should be sitting in the process chamber or pipeline as shown in Figure 16 on page 33.

1. Shut down the process if the process pressure is more than 10 bars. If the pressure is lower there is no need to shut down the process.
2. Close the ball valve.
3. Seal the threads on the fitting body; refer to Figure 14 on page 31.
4. Attach the fitting body to the ball valve and tighten it.
5. Slide the clasp nut of the probe toward the filter, as far as it will go.
6. Insert the probe to the fitting body, and manually tighten the clasp nut to the fitting body.
7. Open the ball valve.
8. Push the probe through the ball valve assembly into the process. If the pressure is high, use the pressing handle that is provided with the probe. If you push the probe hard without using the handle, you may damage the cable.

   Note that the probe must be pushed so deep that the filter is completely inside the process flow.
9. Mark the fitting screw and the clasp nut.
10. Tighten the clasp nut with a fork spanner a further 50 ... 60º (ca. 1/6 turn). If you have a suitable torque spanner, tighten the nut to max 45 ± 5 Nm (33 ± 4 ft-lbs). Refer to Figure 15 on page 32.

NOTE	Take care not to tighten the clasp nut more than 60° to avoid difficulties when opening it.

If you wish to remove the probe from the process, note that you have to pull the probe out far enough. You cannot close the valve if the groove on the probe body is not visible.

Electrical Connections

Refer to local requirements regarding cabling, grounding and galvanic isolator or barrier connections.

WARNING Connect the transmitter always via galvanic isolators or Zener barriers in hazardous environments.

WARNING Be sure that the main power switch of the transmitter is set off before making any electrical installations in hazardous areas.

1. Open the transmitter cover and remove the protective cover of the transmitter base.
2. Thread the power supply wires through the cable gland, see Figure 7 on page 24.
3. Connect the unpowered power supply wires to the connectors: Ch 1 (humidity) and Ch 2 (temperature). Both channels require an own power supply.
4. Replace the protective cover. Turn the transmitter on **ON** with the **ON/OFF** switch, see Figure 24 on page 62.
5. Close the cover. The transmitter is ready for use.

NOTE As Ch 1 is a main output, the transmitter does not operate if only Ch 2 is connected (Ch 2 is optoisolated from transmitter electronics).

When using the transmitter in hazardous locations, the use of galvanic isolators or barriers is essential. The following barrier & isolator are available in Vaisala: barrier No. 210664 (STAHL 9001/51-280-091-141) and galvanic isolator No. 212483 (STAHL 9160/13-11-11). Examples of connections and more information on installation in hazardous locations is given in section Examples of Connections on page 41.

Installation in Hazardous Locations

US and Canadian Requirements

USA (FM): Wiring for intrinsically safe operation is shown in Appendix B, Wiring for Intrinsically Safe Operation, FM, on page 91.

Canada (CSA): Wiring for intrinsically safe operation is shown in Appendix C, Wiring for Intrinsically Safe Operation, CSA, on page 93.

European Requirements

CATEGORY 1 (Zone 0)

HMT360 has to be connected to Exia-certified associated apparatus with galvanic isolation, gas group IIB or IIC.

NOTE If both analog outputs are in use, the Ch 1 (-) and Ch 2 (-) must be short circuited (see Figure 19 on page 41).

CATEGORY 2 or 3 (Zone 1 or 2)

HMT360 has to be connected either to a Zener barrier or galvanic isolator

NOTE If both analog outputs are in use with a galvanic isolator, the Ch 1 (-) and Ch 2 (-) must be short circuited (see Figure 19 on page 41).

Figure 17 on page 39 and Figure 18 on page 40 present examples of galvanic isolators and Zener barrier connections (only Ch 1 connected).

Maximum Cable Resistance Calculation for the Barrier (Vaisala Order Code: 210664)

General specifications of HMT360:

Supply voltage	U_{in} = 24 V (12 ... 35 V)
Maximum current	I_{out} = 20 mA
Minimum operating voltage for HMT360	U_{min} = 12 V (15 V with serial port)

Stahl 9001/51-280-091-141 (values taken from the specifications):

Rated operating voltage	U_N = 20 ... 35 V
Transmitter supply voltage	$U_S = U_N$ - 9.5 V, when $U_N \leq 23.5$ V or U_S = 14 V, when $U_N \geq 23.5$ V
Maximum load	$R_L \leq 350\ \Omega$

Calculation of the maximum cable length from barrier to transmitter:

Cable resistance (as an example)	R_{cable} = 0.085 Ω/m/core (2 × 0.085 Ω/m/pair)

If assuming that the operating voltage would be ≥ 24 V, the maximum acceptable voltage drop U_{drop} in cables is:

$U_{drop} = U_S - U_{min}$

$U_{drop} = 14\ V - 12\ V = 2\ V$

We also know that:

$I_{out} = 20\ mA$

and that total resistance of the cable $R_{cabletot}$ is cable resistance R_{cable} multiplied with the total maximum length of the cables l_{max}:

$R_{cabletot} = R_{cable} \times l_{max}$

From these facts the following equation can be formed:

$U_{drop} = R_{cabletot} \times I_{out}$

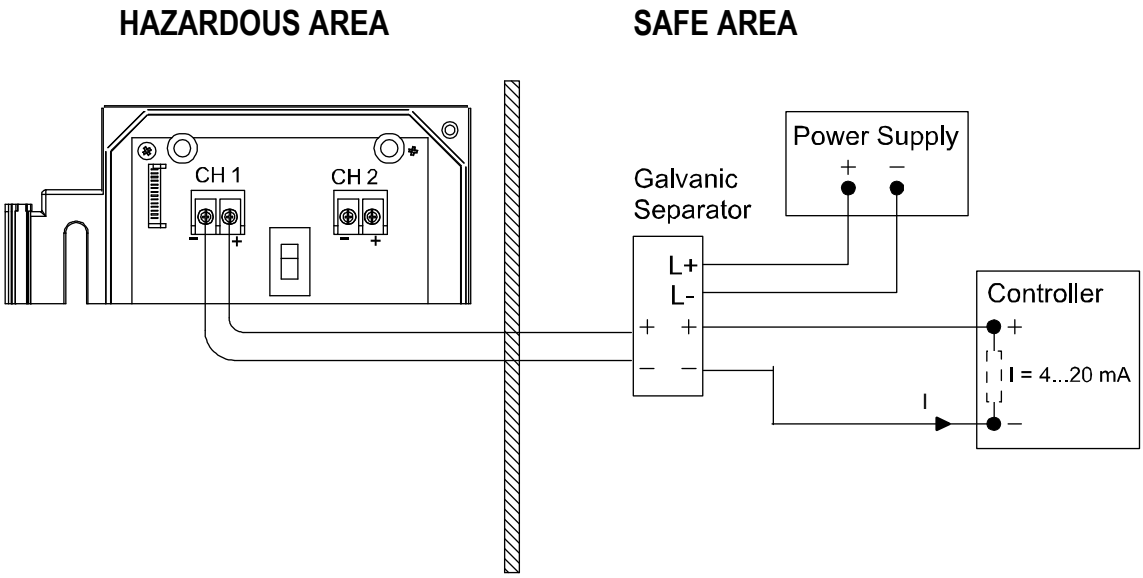
$2 = 2 \times 0.085\ \Omega/m \times l_{max} \times 20\ mA$

$l_{max} = 2\ V / (20\ mA \times 2 \times 0.085\ \Omega/m)$

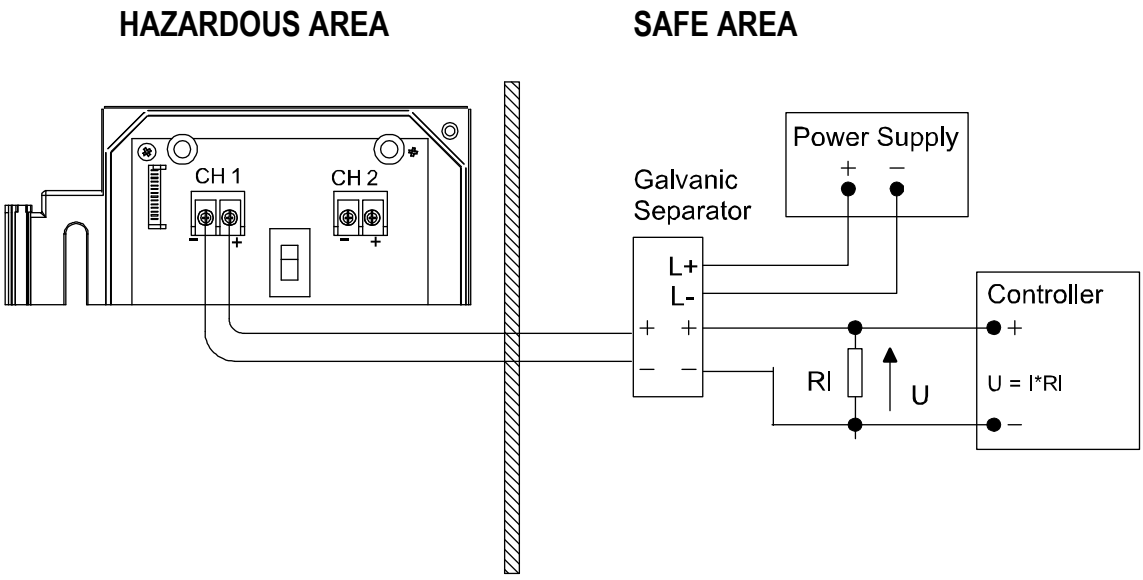
$l_{max} = 588\ m = 1930\ ft$, maximum cable length.

NOTE	If longer cable length is required, use of the galvanic isolators is recommended if possible.

HMT360 Connected to a Galvanic Isolator



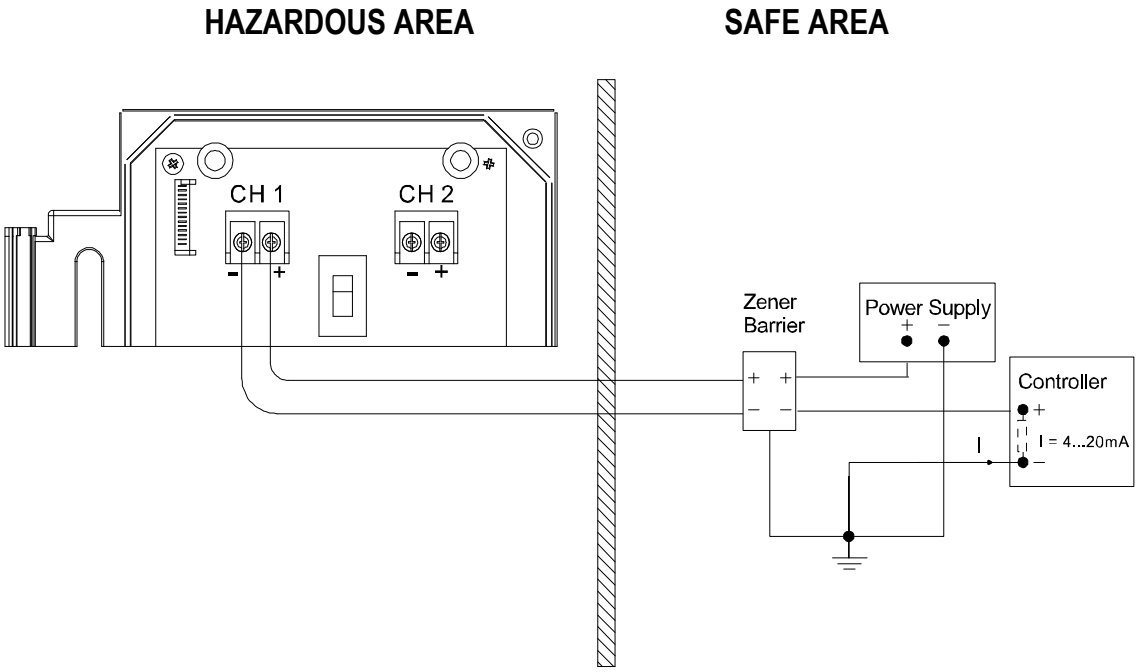
a) current signal controller



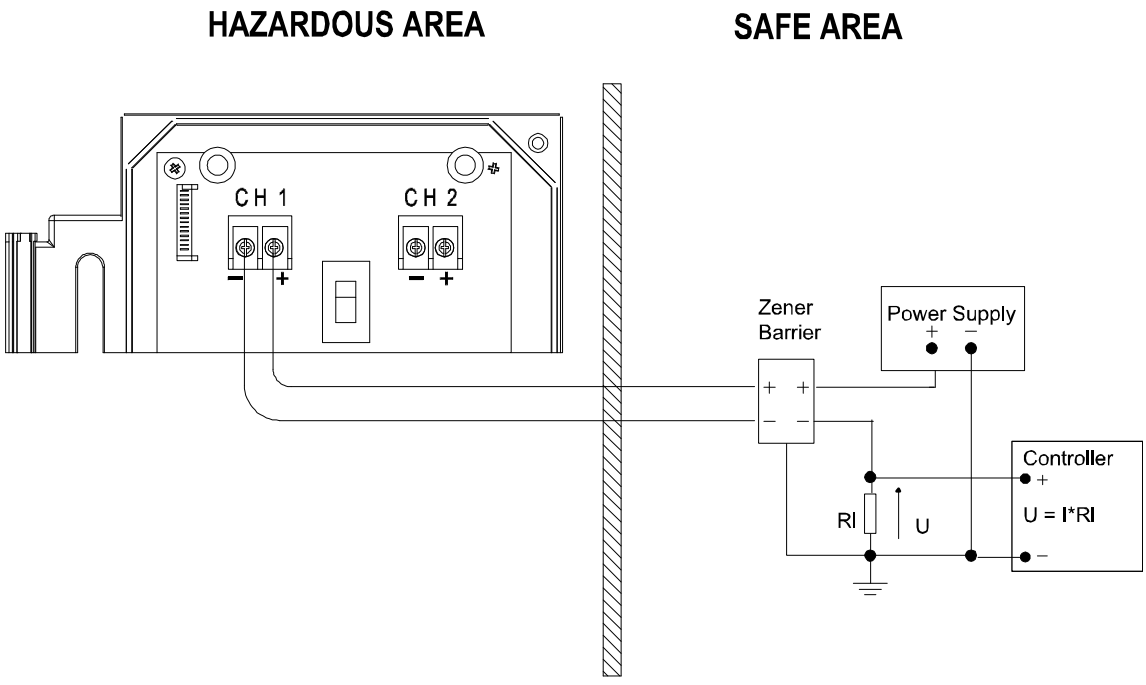
b) voltage signal controller

Figure 17 HMT360 Connected to Galvanic Isolator

HMT360 Connected to a Zener Barrier



a) current signal controller



b) voltage signal controller

Figure 18 HMT360 Connected to a Zener Barrier

Examples of Connections

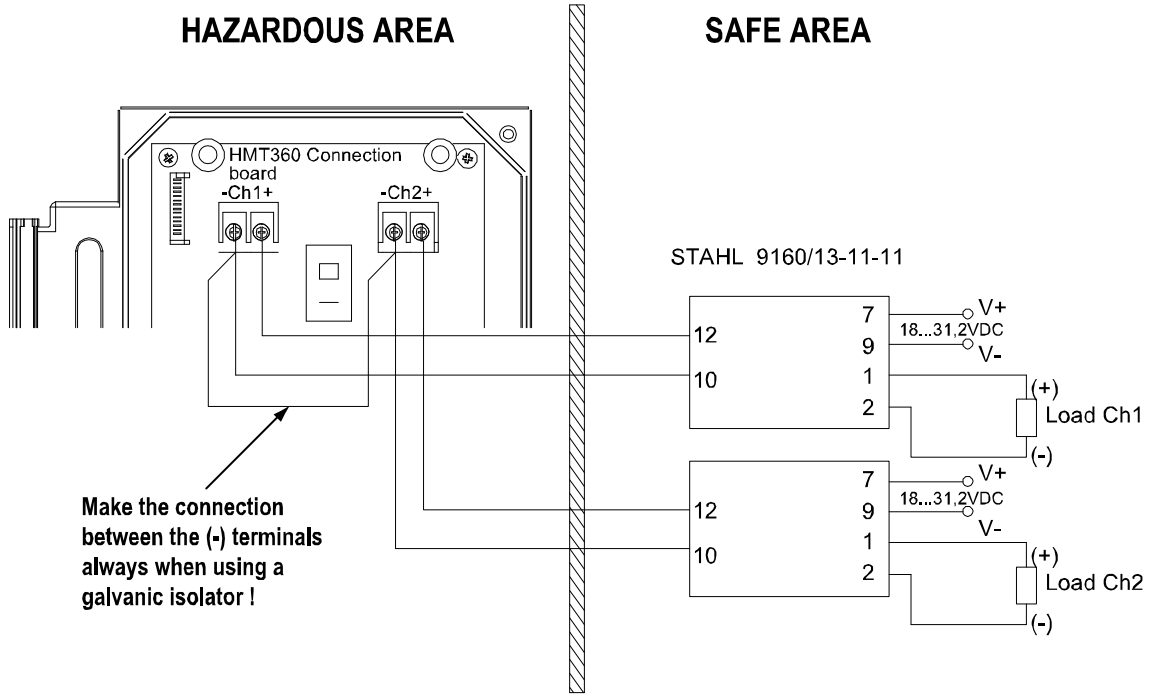


Figure 19 STAHL 9160/13-11-11 (Galvanic Isolator)

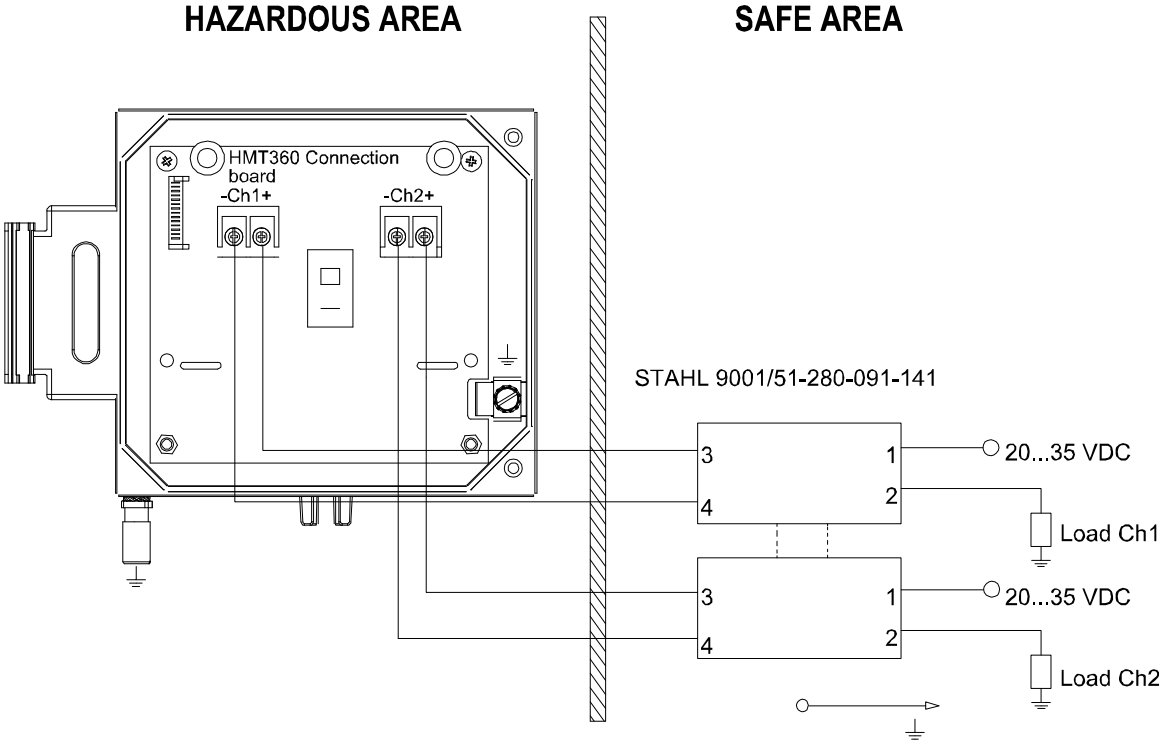


Figure 20 STAHL 9001/51-280-091-141 (Zener Barrier)

Grounding

When grounding the transmitter, follow the local requirements. Use at least 4 mm^2 grounding cable when grounding the transmitter or barrier. Note that the allowed resistance between barrier and system ground must be less than 1 ohm. Use ground terminal located inside or outside of transmitter Figure 21 on page 42:

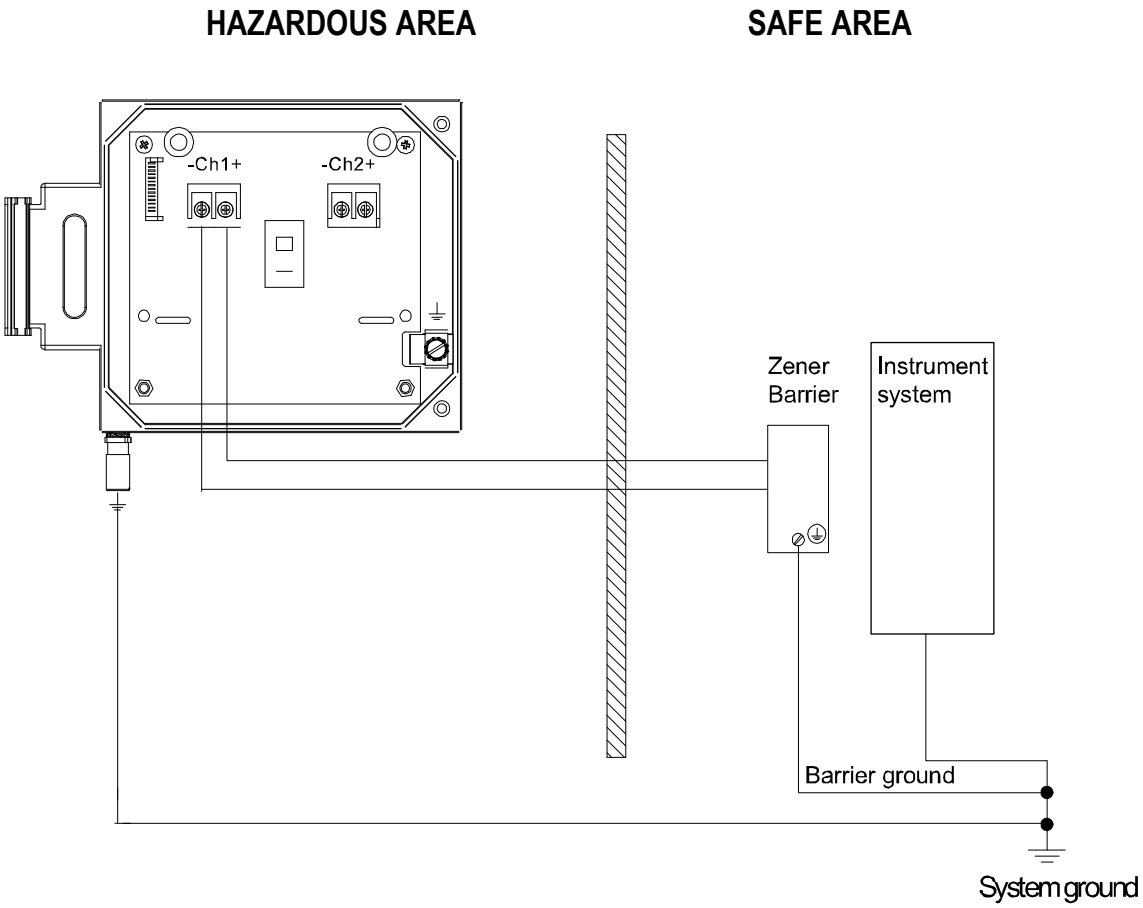


Figure 21 Grounding

CHAPTER 4
OPERATION

This chapter contains information that is needed to operate this product.

Local Interface

HMT360 transmitter has four pushbuttons located on the housing cover. The transmitter can be ordered either with or without a local display. The display/keypad commands (see Display/Keypad Commands on page 46) can be used to scale the outputs and select special output quantities (if the transmitter configuration includes special output quantities). The optional display shows the measurement results.

The keypad pushbuttons are indicated (from left to right) as **C**, **Up**, **Dn**, and **E** (see Figure 22 on page 43):

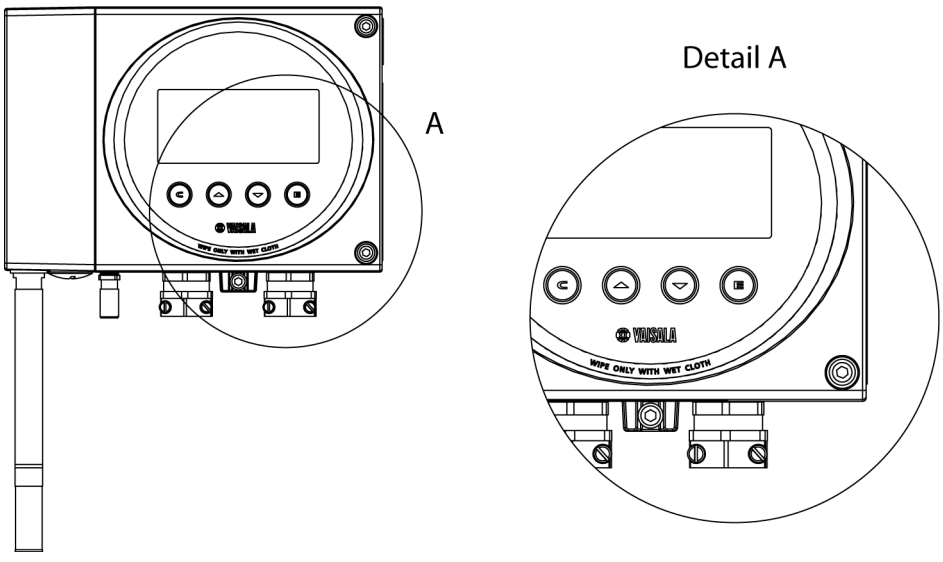


Figure 22 Local Display/Keypad Interface

Power ON/OFF

Open the transmitter cover and flip the internal power switch to position **ON** (up), see Figure 24 on page 62.

WARNING	Avoid static discharge. Always use a wet cloth for wiping the display.

HMT360 with Display

Measurement readings appear on the display after switching power **ON**. The analog output signals can be read from the system or load resistor.

WARNING	Avoid static discharge. Always use a wet cloth for wiping the display.

HMT360 without Display

If the transmitter does not have a display, the red LED indicator on the cover indicates various phases of calibration and possible errors. In normal operation it is not lit. If the LED is lit and all calibration or test DIP switches are disabled, it is an indication of an internal error.

Otherwise, the LED indicates the following:

- LED blinking = calibration of the dry end (offset).
- LED lit = calibration of the wet end (gain).

NOTE	If calibration is concluded but DIP switch settings are not restored, the LED indicator keeps blinking.

DIP Switch Functions

The table below is also printed on the protection board:

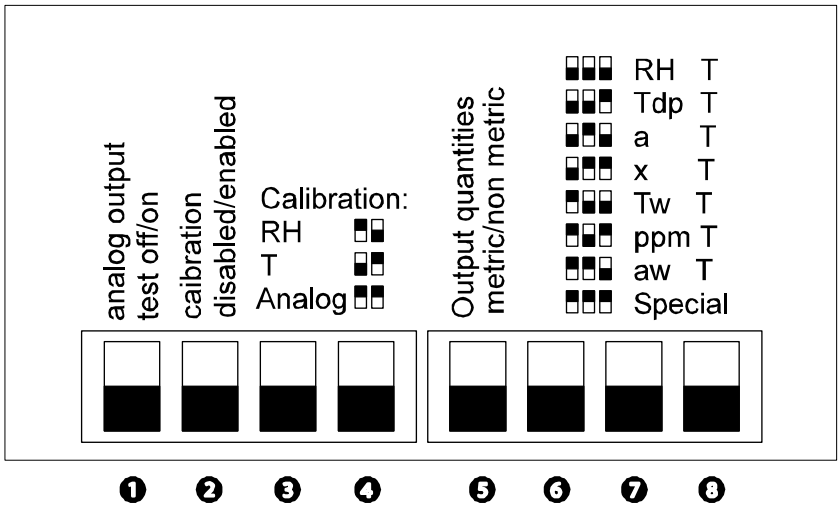


Figure 23 DIP Switch Functions

1: Analog output test on/off

If you turn the switch to on position (up), you can force the outputs to states 4 mA, 12 mA and 20 mA by pressing buttons **Up** and **Dn** on the cover. Outputs return to normal mode when switch is turned down.

2: Calibration Disabled/Enabled

The EEPROMs are write protected. If this switch is in the disabled position (down), it does not allow any calibrations or scalings.

NOTE	Keep this switch always in the disabled position during normal use of the transmitter.

3 and 4: Calibration rh, t, analog

With these combinations you can perform relative humidity, temperature or analog output calibrations with a multimeter or with the transmitter display unit. Turn the DIP switches to the desired position according to the table printed on the protective cover.

5: Output quantities

Determines whether the output units are metric (down) on non-metric.

6, 7 and 8: Select output quantities

With the three DIP switches on the right, you can select the output quantities according to the table printed on the right side of the protective cover. Note that only the ordered quantities can be selected. The special option gives you the choice of setting any ordered quantity to each channel.

NOTE	Always restore the DIP switch settings after having tested the analog outputs or performing the calibration.

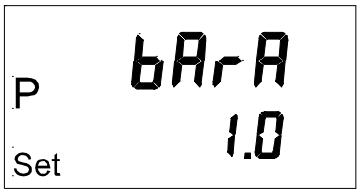
Display/Keypad Commands

NOTE	Chapter 6, Calibration and Adjustment, on page 61 describes separately display/keypad commands for calibration and adjustment.

Setting the Pressure for Calculations

In humidity transmitters, ambient pressure is used for the mixing ratio and wet bulb calculations.

To modify the pressure settings, turn the internal **Calibration Enabled/ Disabled** DIP switch of the transmitter to position **Enabled** (up). Press button **C** on the display cover: text "SCAL" appears on the display. Then press button **E** until the following display appears (the numeric value is always the existing setting, in this example 1.0):



Adjust the pressure reading with buttons **Up** and **Dn**. Acknowledge the value with button **E**. To complete the pressure setting, turn the dip switch back to position disabled (down).

See the pressure conversion table on page Table 6 on page 56.

Selecting Output Quantities

Upper Half of Display

To modify the displayed quantity, turn the **Calibration Enabled/Disabled** DIP switch of the transmitter to position **Enabled** (up). Select the required quantity with button **Up** on the display cover, and acknowledge the value with button **E**. To complete the selections, turn the DIP switch back to position disabled (down).

Character	Quantity	Abbreviation	Availability	Metric Unit	Nonmetric Unit
0	relative humidity	RH	A, D	%RH	%RH
1	temperature	T	A, D, F, H	°C	°F
2	dewpoint temperature	Td	D	°C	°F
3	absolute humidity	a	D	g/m^3	gr/ft^3
4	mixing ratio	x	D	g/kg	gr/lb
5	wet bulb temperature	Tw	D	°C	°F
6	mass concentration of water	ppmw	H	ppm_w	ppm_w
7	water activity	aw	H, F	0 ... 1	0 ... 1
8	relative humidity of saturation	RS	H	%RS	%RS
9	saturation temperature	Ts	H	°C	°F

The characters used to indicate availability in the table above:

A = Available for HMT360 standard version

D = Available for HMT360 with optional calculations

F = Available for HMT360 Moisture and Temperature in oil transmitter

H = Available for HMT360 Moisture and Temperature in Jet Fuel transmitter

Lower Half of Display

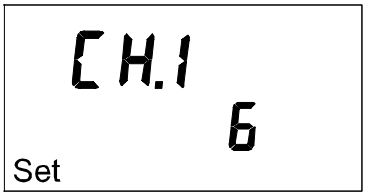
The output quantities metric/non metric DIP switch can be used to select between °C and °F.

It is possible to check the pressure setting of the transmitter by pressing button **Dn**. To return to the temperature reading, press button **Dn** again.

Selecting Analog Outputs

You can select the output quantities for channels 1 and 2 by turning the **Calibration Enabled/Disabled** DIP switch of the transmitter to position **Enabled** (up) and the three output selection DIP switches to position special (all up).

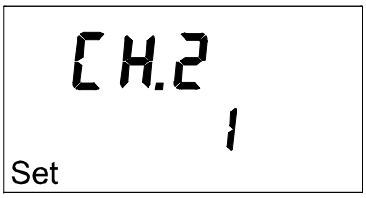
Press button **C** on the display cover: text "SCAL" appears on the display. Then press button **E** until the following display appears:



The characters on the second line of the display in this menu correspond to the quantities according to the table in section Selecting Output Quantities on page 47.

Select the quantity for Ch 1 with buttons **Up** and **Dn** and acknowledge the selection with button **E**.

If the transmitter is equipped with two analog channels, select the quantity for Ch 2 in the same way, for example:

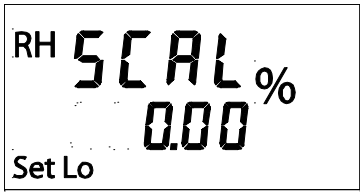


Press button **C** to exit the display command mode or continue by setting the pressure.

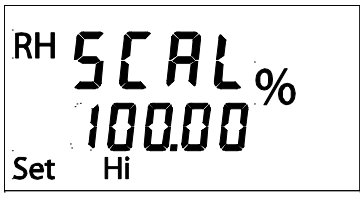
NOTE	Remember to restore the DIP switch settings.

Scaling Analog Outputs

Turn the internal **Calibration Enabled/Disabled** DIP switch of the transmitter to upward position (on). Press button **C** on the display cover and a text similar to the following appears:



Numbers on the second line indicate the low end scaling of Ch 1 currently stored in the transmitter memory. The text "Set Lo" on the lower left corner indicates that you can now change the low end scaling with buttons **Up** and **Dn**. Acknowledge the value with button **E** and a text similar to the following appears:



Numbers on the second line indicate the high end scaling of Ch 1. The text "Set Hi" on the lower left-hand corner indicates that you can now change the high end scaling with buttons **Up** and **Dn**. Acknowledge with button **E**.

If there is another channel available, the display shifts to the scaling menu of Ch 2. You can now scale the analog outputs for the Ch 2 in the same way as described above.

Press button **C** to exit the display command mode or continue by selecting the output quantities. This menu starts automatically after the scaling menu only if the output selection DIP switches are on the position special (all up) from the beginning.

NOTE	Remember to restore the DIP switch settings.

Serial Interface

WARNING The serial interface **MUST NOT** be used in hazardous areas.

Use the serial interface for calibration and testing purposes in safe areas only. Always use the serial interface cable (optional accessory, Vaisala order code: 25905ZZ). Connect one end of the cable to the serial port of your computer and the other to the connector marked "RS232C" on the electronics unit of the transmitter (see Figure 7 on page 24).

NOTE With serial communication the current consumption increases approximately to 7 mA and the transmitter is not able to operate with 4 mA. Therefore, it is recommended to use serial communication only temporarily for changing settings or for calibrating the transmitter in a safe area. With serial port, the minimum supply voltage is 15 VDC.

NOTE The transmitter incorporates a serial interface detector. However, not all terminals or PC serial ports (for example, optoisolated or ports not meeting RS232C standards) recognize this standard. If the communication is not possible via a serial interface, use a forced activation by pressing simultaneously buttons **Up** and **E** on the transmitter cover. To deactivate the forced activation, press these buttons again or reset the transmitter. If the transmitter does not receive any commands for half an hour, it automatically closes the serial communication.

Serial Communication Settings

Table 5 Serial Communications Settings

Parameter	Value
bauds	2400
parity	none
data bits	8
stop bits	1

CAUTION When using the serial interface, be sure that power supply and serial interface are not connected to the same ground (use a floating power supply or hand-held serial interface device).

To start issuing commands, make sure that HMT360 is connected to a serial port of your computer and that the terminal session is open. Issue commands by typing them on your computer according to the following instructions. In these commands, <cr> stands for pressing Enter (on your computer keyboard).

Setting the Analog Outputs

ASEL Selecting Analog Outputs

Syntax: **ASEL** [*xxxyyy*]<cr>

where

xxx = Quantity of Ch 1

yyy = Quantity of Ch 2

Turn the internal DIP switch **Calibration Enabled/Disabled** to position **ON** before the selecting the analog outputs and return it to position **OFF** after making the selection. Output quantities and their abbreviations are listed in the table below:

Character	Quantity	Abbreviation	Availability	Metric Unit	Nonmetric Unit
0	relative humidity	RH	A, D	%RH	%RH
1	temperature	T	A, D, F, H	°C	°F
2	dewpoint temperature	Td	D	°C	°F
3	absolute humidity	a	D	g/m^3	gr/ft^3
4	mixing ratio	x	D	g/kg	gr/lb
5	wet bulb temperature	Tw	D	°C	°F
6	mass concentration of water	ppmw	H	ppm_w	ppm_w
7	water activity	aw	H, F	0 ... 1	0 ... 1
8	relative humidity of saturation	RS	H	%RS	%RS
9	saturation temperature	Ts	H	°C	°F

Example:

```
>asel rh t
Ch1 RH lo : 0.00 %RH
Ch1 RH hi : 100.00 %RH
Ch2 T lo: -40.00 'C
Ch2 T hi: 100.00 'C
>
```

S Scaling Analog Outputs

Syntax: **S** [*zz aa.a bb.b*]<cr>

where

zz = Quantity (RH, T, Td, x, a, Tw, ppm, aw, RS, Ts)

aa.a = Lower limit of the quantity

bb.b = Upper limit of the quantity

Turn the internal DIP switch **Calibration Enabled/Disabled** to position **ON** before the scaling the analog outputs and return it to position **OFF** after scaling.

Example:

```
>srh 0 100
RH lo: 0.00 %RH
RH hi: 100.00 %RH
>
```

Adjustment Commands

Turn the internal DIP switch **Calibration Enabled/Disabled** to position **ON** before the adjustment and return it to position **OFF** after the adjustment.

CRH Relative Humidity Adjustment

NOTE	Read also the calibrator, for example HMK15, manual and refer to page 19 of that manual for more detailed instructions on salt bath calibration and adjustment.

Syntax: **CRH**<cr>

The transmitter asks and measures relative humidity and calculates the calibration coefficients.

Example:

```
>crh
RH  :  1.82    1. ref ? 0
 Press any key when ready ...
RH  :  74.222  2. ref ? 75
OK
>
```

The OK indicates that the adjustment was succesful.

CT Temperature Adjustment

Syntax: **CT**<cr>

The transmitter asks and measures temperature readings and calculates the calibration coefficients.

Example:

```
>ct
T  :  0.811   1. ref ? 0.5
 Press any key when ready ...
T  :  99.122  2. ref ? 99.5
OK
>
```

The OK indicates that the adjustment was succesful. When performing one-point adjustment press only Enter for the second reference.

Output Commands

ITEST Testing Analog Outputs

NOTE	Before giving command **ITEST**, reset the transmitter with command **RESET**, see section RESET Transmitter Reset on page 57.

Syntax: **ITEST** [*aa.aaa bb.bbb*]<cr>

where

aa.aaa = Current value to be set for Ch 1 (mA)

bb.bbb = Current value to be set for Ch 2 (mA)

This command outputs the current value of each channel and the corresponding control signal of the digital-to-analog converter.

Example:

```
>itest 8 12
 8.00000   403   12.00000   7DF
>itest
 7.00150   30A   11.35429   73E
>
```

The set current values remain valid until you issue the command **ITEST** without readings or reset the transmitter. With this command the desired outputs of the transmitter are shown.

NOTE	When outputting low currents from Ch 1, remember to remove RS232C-cable while reading the current output, because of the increased current consumption for using RS port.

SEND Outputting Measurement Values

Syntax: **SEND**<cr>

This command outputs the measured values in one point.

R Activating Continuous Output

Syntax: **R**<cr>

With the command **R** the transmitter outputs measured values continuously.

S Stopping Continuous Output

Syntax: **S**<cr>

The continuous outputting is stopped with the command **S**. If outputting is active, this command is not echoed.

INTV Setting Output Interval

Syntax: **INTV** [*n xxx*]<cr>

where

n = 1 ... 255

xxx = S, MIN or H

Sets the output interval when the transmitter outputs measurement readings. The time interval is used when the continuous output is active.

Example, the output interval is set to 10 minutes:

```
>intv 10 min
Output interval:   10 MIN
>
```

PRES Setting Ambient Pressure for Calculations

Syntax: **PRES** [*aaaa.a*]<cr>

where

aaaa.a = Pressure (bar_a)

Turn the internal DIP switch **Calibration Enabled/Disabled** to position **ON** before setting the pressure and return it to position **OFF** after making the setting.

Example:

```
>pres 12
Pressure        :     12.0 bara
>
```

Table 6 Pressure Conversion Chart

	FROM	hPa/mbar	mmHg/Torr	inHg	atm	bar	psi
	hPa/ mbar	1	1.333224	33.86388	1013.25	1000	68.94757
TO	mmHg/ Torr	0.7500617	1	25.40000	760	750.0617	51.71493
	inHg	0.02952999	0.03937008	1	29.921	29.52999	2.036021
	atm	0.00098692	0.00131597	0.033422	1	0.98692	0.068046
	bar	0.001	0.001333224	0.03386388	1.01325	1	0.06894757
	psi	0.01450377	0.01933678	0.4911541	14.6962	14.50377	1

Example:

29.9213 inHg = 29.9213 × 33.86388 = 1013.25 hPa / mbar

NOTE Conversions from mmHg and inHg are defined at 0 °C.

FILT Output Filtering

Syntax: **FILT** [*a.aaa*]<cr>

where

a.aaa = 0.1 ... 1

1 = No filtering

0.5 = Average of last two measurements

0.1 = Average of ca. 16 measurements

This commands sets the measurement result filtering.

Example:

```
>filt 1
Filter          :  1.0000
>filt 0.5
Filter          :  0.5000
>filt 0.1
Filter          :  0.1000
>
```

Resetting the Transmitter

RESET Transmitter Reset

Syntax: **RESET**<cr>

This command resets the device.

CHAPTER 5
MEASURING AT OVERPRESSURE

This chapter provides you with important information concerning measurement in conditions with pressure higher than the normal atmospheric pressure.

The probes HMP364 and HMP368 are designed for humidity measurement at overpressure. The maximum measurement pressures depend on the probe as follows:

HMP364: 0 ... 100 bar (10 MPa), for pressurized rooms and processes, probe is provided with a nut, fitting screw and sealing washer

HMP368: 0 ... 40 bar (4 MPa), for pressurized pipelines, ball valve set available

The accuracy of the dewpoint measurement is affected by pressure in the measurement chamber. The actual pressure in the sampling cell is required to be set to the transmitter by using the serial line command **PRES** (see section PRES Setting Ambient Pressure for Calculations on page 56 or by using the keypad commands, see section Setting the Pressure for Calculations on page 46).

Pressure Regulator Recommended

When sampling pressurized processes exceeding the maximum measurement pressure of the probe, the pressure in the measurement chamber must be regulated to the acceptable level or below. It is recommended to use pressure regulator before the measurement chamber to prevent remarkable pressure variations.

CHAPTER 6

CALIBRATION AND ADJUSTMENT

This chapter contains instructions for checking the calibration and adjusting this product.

In this User's Guide the term "calibration" refers to comparing the device's reading against a reference concentration. "Adjustment" refers to changing the device's reading to correspond to the reference concentration.

Calibration Interval

HMT360 is calibrated as shipped from the factory. Typical calibration interval is one year. In demanding applications it may be advisable to make the first calibration check earlier.

Factory Calibration and Adjustment

The device (or the probe only) can be sent to Vaisala Service Centers for calibration and adjustment. See section Technical Support on page 74 for contact information.

User Calibration and Adjustment

Calibration and adjustment is carried out by using the keypad or by using serial commands. The following additional equipment is needed in adjustment of HMT360:

- a power supply for the channel(s) to be calibrated (12 ... 24 VDC),
- a multimeter for HMT360 without a display, and
- the calibrated references.

First, the electronics unit is removed from the transmitter base to perform the calibration and adjustment in safe area. Second, the power supply and a multimeter is connected to the electronics unit according to the following instructions.

Removing the Electronics Unit

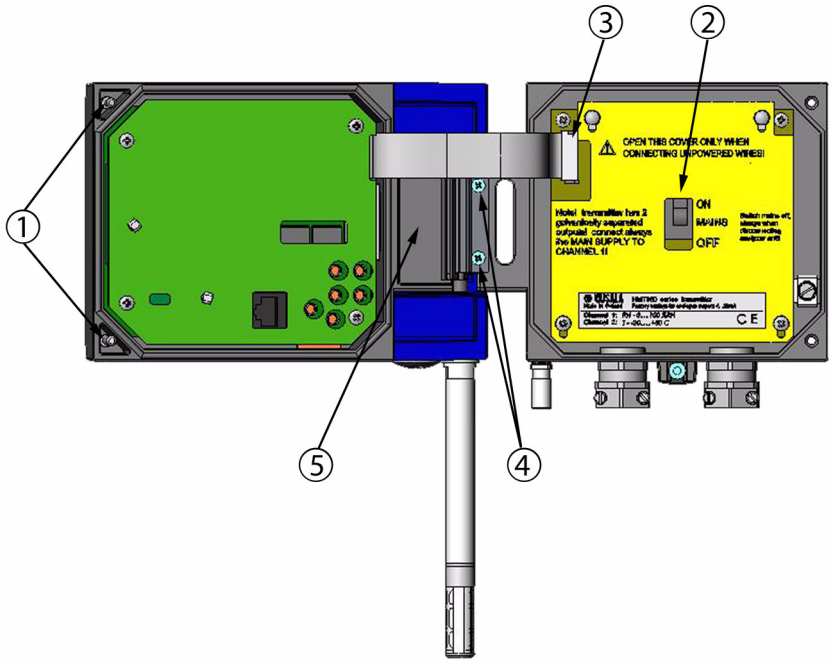


Figure 24 Detaching the Electronics Unit with Probe for Calibration and Adjustment

1. Unfasten the screws and open the cover.
2. Switch the transmitter off with the **ON/OFF** switch.
3. Disconnect the flat cable by lifting it carefully, for example with a screwdriver.
4. Remove the two screws holding the hinge support. Remove the hinge support.
5. Turn the electronics unit slightly upwards to release it from the hinges. Leave the transmitter base with the cable connections on place. When putting the electronics unit back to place, attach the upper hinge first. Remember to attach the hinge support.

Connections

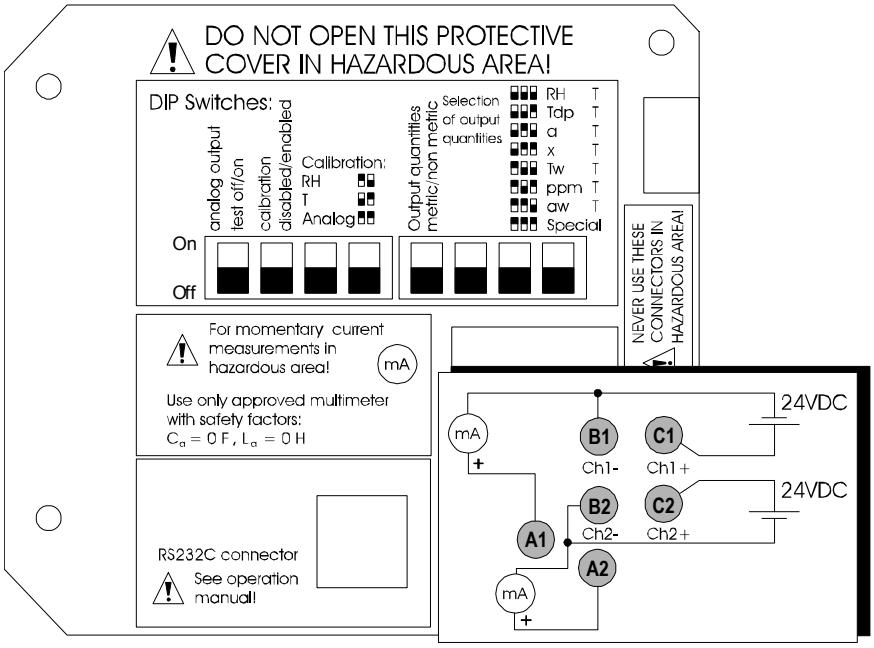


Figure 25 Connecting Power Supply and Multimeter for Calibration

1. Connect a power supply (12 ... 24 VDC, with a serial port the minimum supply voltage is 15 VDC) to the terminals B1 (-) and C1 (+) (Ch 1) with banana plugs, see Figure 25 on page 63.
2. Connect the multimeter in series with the supply, B1 (-) and A1 (+).
3. Follow the same procedure with Ch 2 using the terminals B2 (-) and C2 (+). When calibrating both channels at the same time, use two galvanically separated power supplies.

You can now calibrate or check the humidity and temperature or the analog outputs according to the instructions given in this chapter.

If the current measurement is needed in a hazardous area, the multimeter is connected to the terminals A1/A2 (+) and B1/B2 (-). Use only an approved multimeter.

WARNING The power supply connectors (C1 and C2) **MUST NOT** be used in hazardous areas. For calibration and adjustment in a hazardous area use only an approved multimeter, which fulfills the safety factors printed on the protective cover.

Calculating Correspondence of Current Values and Output Quantities

When using HMT360 without a display, calibration and adjustment is carried out by using a multimeter. Use the following equations to calculate the current values corresponding to the reference output quantities.

$$I = 4\ \text{mA} + 16\ \text{mA} \cdot \frac{Q_{\text{ref}} - Q_{\text{min}}}{Q_{\text{max}} - Q_{\text{min}}}$$

where

Q_{ref} = Reference value of the calibrated quantity

Q_{min} = Reference value of the calibrated quantity

Q_{max} = Value corresponding to 20 mA

Example 1:

Relative humidity scaling 0 ... 100 %RH, reference 11.3 %RH:

$$I = 4\ \text{mA} + 16\ \text{mA} \cdot \frac{11.3\ \%\text{RH} - 0\ \%\text{RH}}{100\ \%\text{RH} - 0\ \%\text{RH}} = 5.808\ \text{mA}$$

Example 2:

Temperature scaling -40 ... +120 °C, reference 22.3 °C:

$$I = 4\ \text{mA} + 16\ \text{mA} \cdot \frac{22.3^\circ\text{C} - 40^\circ\text{C}}{120^\circ\text{C} - 40^\circ\text{C}} = 10.230\ \text{mA}$$

Relative Humidity Adjustment

Automatic Two-Point Adjustment (Only HMT360 with Display)

The automatic adjustment procedure is a user friendly way to adjust the HMT360 with salt solutions; you do not have to feed the reference values to the HMT360. The transmitter displays the accurate value based on the measured temperature and the Greenspan table stored into the transmitter memory. The display chart of the adjustment procedure is presented in Figure 26 on page 66.

1. Set the internal DIP switch **Calibration Enabled/Disabled** to position **ON** and select RH calibration by using switches 3 and 4 (see section DIP Switch Functions on page 45).
2. Remove the filter and insert the probe into a measurement hole of the LiCl salt chamber in the humidity calibrator. Acknowledge by pressing button **E**. Alternatively select the 0.1 (humidity in nitrogen) with buttons **Up** and **Dn**. Acknowledge with button **E**.
3. You must now wait for the measured reading to stabilize (10 ... 15 min). When the transmitter detects that the reading is stable, it automatically stores the correction. When the text "Auto" is displayed on the screen, continue with the next step.
4. Insert the probe into a measurement hole of the NaCl salt chamber in the humidity calibrator. Acknowledge by pressing button **E**. Alternatively you can select K_2SO_4 value with buttons **Up** and **Dn**.
5. You must again wait for the measured reading to stabilize (10 ... 15 min). When the transmitter detects that the reading is stable, it automatically stores the correction. The text "Cal Pass" is displayed after the adjustment is performed.

NOTE	Remember to restore the DIP switch settings.

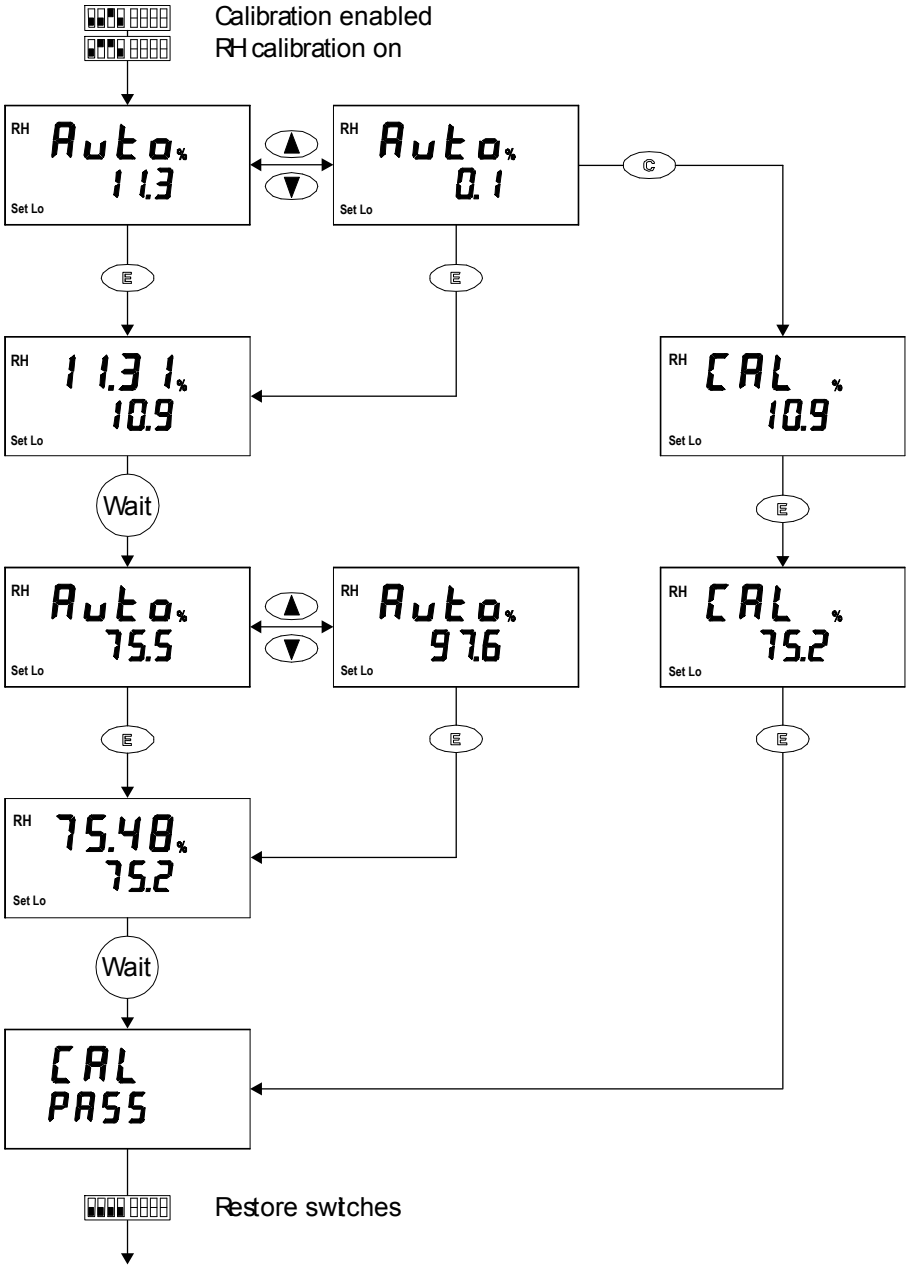


Figure 26 Display Chart of the Automatic Adjustment Procedure

Manual Adjustment

This section contains separate manual adjustment procedures for transmitters with and without display. You can perform the low-end adjustment only (one-point adjustment), or adjust both low and high end of the measurement (two-point adjustment).

NOTE If you use serial commands, please refer to section Adjustment Commands on page 53.

Low End Adjustment (HMT360 without Display)

1. Connect the power supply and multimeter as instructed in section Connections on page 63.
2. Remove the filter and insert the probe into a measurement hole of the reference chamber (for example LiCl: 11 %RH) in the humidity calibrator.
3. Power up the transmitter.
4. Set the internal DIP switch **Calibration Enabled/Disabled** to position **ON** and select RH calibration by using switches 3 and 4 (see section DIP Switch Functions on page 45).
5. The LED indicator will start blinking. According to the calibrator used, wait at least 10 ... 15 minutes for the sensor to stabilize; use a multimeter to monitor the stabilization.
6. Press buttons **Up** and **Dn** to adjust the multimeter reading to correspond the reference value (calculate the current value corresponding to the reference humidity by using the equations presented in Calculating Correspondence of Current Values and Output Quantities on page 64). Press button **E** to conclude the adjustment.
7. To continue with the high end (two-point) adjustment follow the instructions in the next section.

   If the low end adjustment is sufficient, press button **E** again to conclude the calibration. Also restore the DIP switch settings; set the calibration DIP switch to position disabled (down).

High End Adjustment (HMT360 without Display)

1. After having made the low end adjustment, insert the probe into a measurement hole of the NaCl (75 %RH) salt chamber in the humidity calibrator. Please, note that the difference between the two humidity references must be at least 30 %RH.
2. The LED indicator lights up. Wait at least 10 ... 15 minutes for the sensor to stabilize; use a multimeter to monitor the stabilization.
3. Press buttons **Up** and **Dn** to adjust the multimeter reading. Calculate the current value corresponding to the reference humidity by using the equations presented in Calculating Correspondence of Current Values and Output Quantities on page 64.
4. Conclude the adjustment with button **E**.
5. Restore the DIP switch settings. Set the calibration DIP switch to position disabled (down).

Low End Adjustment (HMT360 with Display)

1. Connect the power supply as instructed in section Connections on page 63. The measurement readings will be visible on the display during calibration, but you can also connect a multimeter to check the analog output readings.
2. Remove the filter and insert the probe into a measurement hole of the dry end reference chamber (for example LiCl: 11 %RH) in the humidity calibrator.
3. Power up the transmitter.
4. Set the internal DIP switch **Calibration Enabled/Disabled** to position **ON** and select RH calibration by using switches 3 and 4 (see section DIP Switch Functions on page 45).
5. Press button **C** to ignore the automatic adjustment procedure. The humidity reading measured by the transmitter appears on the display and on the lower left corner you can see the text "Set Lo".
6. According to the calibrator used, wait at least 10 ... 15 minutes for the sensor to stabilize; use the transmitter display to monitor the stabilization.
7. Press buttons **Up** and **Dn** to adjust the display reading. Press button **E** to conclude the low end adjustment.
8. To continue with the high end (two-point) adjustment follow the instructions in the next section.

   If the low end adjustment is sufficient, press button **E** again to conclude the calibration. Also restore the DIP switch settings; set the calibration DIP switch to position disabled (down).

High End Adjustment (HMT360 with Display)

1. After having made the low end adjustment, insert the probe into a measurement hole of the NaCl (75 %RH) salt chamber in the humidity calibrator. Please, note that the difference between the two humidity references must be at least 30 %RH.
2. The readings measured by the transmitter appear on the display, as well as the text "Set Hi" on the lower left hand corner.
3. Wait at least 10 ... 15 minutes for the sensor to stabilize; use the transmitter display to monitor the stabilization.
4. Press buttons **Up** and **Dn** to adjust the display and conclude the adjustment with button **E**.
5. Restore the DIP switch settings. Set the calibration DIP switch to position disabled (down).

One-Point Temperature Adjustment

NOTE	Always use a high quality standard for adjusting the temperature.

NOTE	If you use serial commands, please refer to section Adjustment Commands on page 53.

1. Set the internal DIP switch **Calibration Enabled/Disabled** to position **ON** and select T calibration by using switches 3 and 4 (see section DIP Switch Functions on page 45).
2. The temperature value measured by the transmitter appears on the display as well as the text "Set Lo" on the lower left corner. If the transmitter has no display, the LED indicator starts to blink.
3. Let the sensor stabilize; use a multimeter or the transmitter display to monitor the stabilization.
4. Press buttons **Up** and **Dn** to adjust the display or multimeter reading to correspond to the reference value (when using a multimeter calculate the current value corresponding to the reference humidity by using the equations presented in Calculating Correspondence of Current Values and Output Quantities on page 64).
5. Conclude the one-point adjustment by pressing button **E** twice.

ACAL Analog Output Calibration

Syntax: **ACAL**<cr>

Connect HMT360 to a multimeter. Issue the **ACAL** command:

1. Disconnect the serial cable from the transmitter while reading the multimeter value for the Ch 1 (I1).
2. Reconnect the serial cable. Type the multimeter reading and press Enter.
3. Type the higher current multimeter reading and press Enter.

Example:

```
>acal
 Ch1 I1 ( mA  )  ? 4.846
 Ch1 I2 ( mA  )  ? 19.987
>
```

CHAPTER 7
MAINTENANCE

This chapter provides information that is needed in basic maintenance of the product.

Periodical Checking and Cleaning

Transmitter Housing and Probe

WARNING	Avoid static discharge. Always use a wet cloth for wiping the display.

The electronics unit of the transmitter, as well as the probe, can be removed and replaced in the field. See section Removing the Electronics Unit on page 62 for detailed information.

All other maintenance must be performed by qualified Vaisala personnel. If a transmitter is damaged, contact your nearest Vaisala Service Center. See section Product Returns on page 74 for contact information.

CHAPTER 8
TROUBLESHOOTING

This chapter describes common problems, their probable causes and remedies, and contact information.

Diagnostics

Operation Errors

The following symptoms indicate an operation error of the HMT360:

- The analog output(s) current drops below 4 mA.
- Transmitters with display: Display shows an error code; see Table 7 on page 74.
- Transmitters without display: The LED on the cover is lit when no calibration is going on.
- Serial command **ERRS** reports an error; see Table 7 on page 74.
- Serial port outputs asterisks "*" instead of measurement readings.

In the case of error:

- Check that the probe is undamaged.
- Check that the probe module is connected properly. If it is not, reconnect the probe module and reset the transmitter.
- Check that the humidity and temperature sensors are undamaged and dry. If there is condensed water on the sensors, let it dry.

In case of constant error, contact the Vaisala Helpdesk. See section Technical Support on page 74 for contact information.

Table 7 Error Codes

Error Code on Display	Error Code on Serial Line	Typical Cause
RH error	RH error	HUMICAP® humidity sensor open circut or short circut. Can be caused by condensed water, or damage to sensor or probe.
T error	T error	Pt100 temperature sensor open circut or short circuit. Can be caused by condensed water, or damage to sensor or probe.
ADC error	Prb error	Probe module disconnected.
CPU EEPROM error	EE error	Hardware failure in transmitter.
PRB EEPROM error	EEP error	Hardware failure in probe module.

Analog Output Test

Analog outputs can be tested with dip switch 1, see DIP Switch Functions on page 45 for details.

Technical Support

For technical questions, contact the Vaisala technical support by e-mail at helpdesk@vaisala.com. Provide at least the following supporting information:

- Name and model of the product in question
- Serial number of the product
- Name and location of the installation site
- Name and contact information of a technically competent person who can provide further information on the problem.

Product Returns

If the product must be returned for service, see www.vaisala.com/returns.

For contact information of Vaisala Service Centers, see www.vaisala.com/servicecenters.

CHAPTER 9

TECHNICAL DATA

This chapter provides technical data of the product.

Performance

Relative Humidity

Table 8 Relative Humidity Specifications

Property	Description / Value
Measurement range	0 ... 100 %RH
Accuracy (including non-linearity, hysteresis and repeatability)	
with HUMICAP® 180 and HUMICAP® 180R at +15 ... 25 °C at -20 ... +40 °C at -40 ... +180 °C	for typical applications for typical applications ±1 %RH (0 ... 90 %RH) ±1.7 %RH (90 ... 100 %RH) ±(1.0 + 0.008 × reading) %RH ±(1.5 + 0.015 × reading) %RH
with HUMICAP®180L2 at -10 ... +40 °C at -40 ... +180 °C	for applications with demanding chemical environment ±(1.0 + 0.01 × reading) %RH ±(1.5 + 0.02 × reading) %RH
Factory calibration uncertainty (+20 °C)	±0.6 %RH (0 ... 40 %RH) ±1.0 %RH (40 ... 97 %RH) (Defined as ±2 standard deviation limits. Small variations possible, see also calibration certificate.)
Response time (90 %) for HUMICAP® 180 and HUMICAP® 180L2 at +20 °C in still air	8 seconds with grid filter 20 seconds with grid + steel netting 40 seconds with sintered filter
Response time (90 %) for HUMICAP® 180R at +20 °C in 0.1 m/s air flow	17 seconds with grid filter 50 seconds with grid + steel netting 60 seconds with sintered filter

Temperature (+ Operating Pressure Ranges)

Table 9 Temperature Specifications

Property	Description / Value
HMP361	-40 ... +60 °C
HMP363 80 °C	-40 ... +80 °C
HMP363 120 °C	-40 ... +120 °C
HMP364	-70 ... +180 °C, 0 ... 10 MPa (0 ... 100 bar)
HMP365	-70 ... +180 °C
HMP367	-70 ... +180 °C
HMP368	-70 ... +180 °C, 0 ... 4 MPa (0 ... 40 bar)
Accuracy at +20 °C	± 0.2 °C
Accuracy over temperature range	See graph below
Sensor	Pt 1000 RTD 1/3 Class B IEC 751

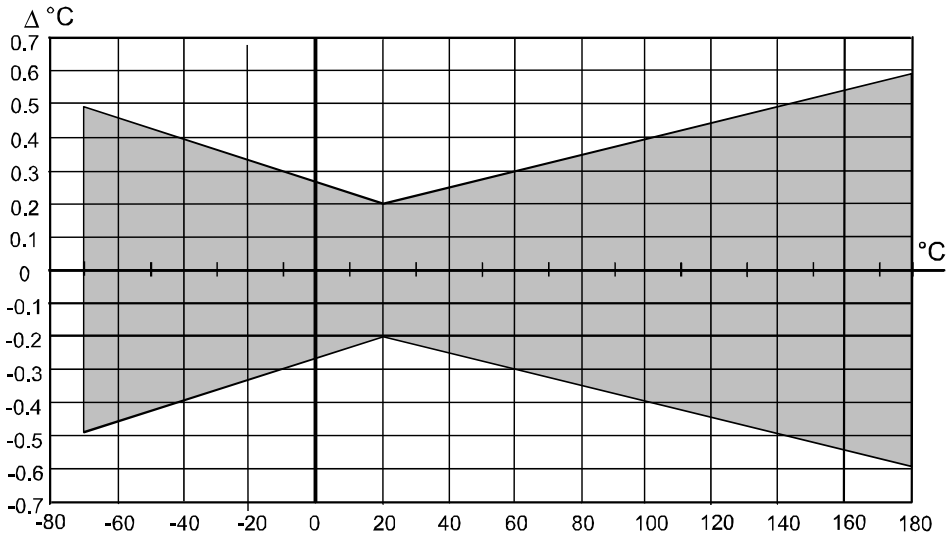


Figure 27 Accuracy over Temperature Range

Water Activity in Jet Fuel Applications

Table 10 Water Activity in Jet Fuel Applications Specifications

Property	Description / Value
Measurement range	0 ... 1 a_w at -40 ... +180 °C (-40 ... +356 °F)
Accuracy when calibrated against high quality, certified humidity standards salt solutions (ASTM E104-85)	 ± 0.01 (0 ... 0.9) ± 0.02 (0.9 ... 1.0) ± 0.02 (0 ... 0.9) ± 0.03 (0.9 ... 1.0)
Response time (90 %) at +20 °C in still oil (stainless steel filter)	10 min
Humidity sensor	Vaisala HUMICAP®
Calculated variables available	mass concentration of water relative humidity of saturation saturation temperature
Accuracy of the water content	better than ± 15 % of the reading

Calculated Variables (Typical Ranges)

With HMP361 Probe

Table 11 HMP361 Calculated Variables Specifications

Property	Description / Value
Dewpoint temperature	-40 ... +60 °C
Mixing ratio	0 ... 160 g/kg d.a.
Absolute humidity	0 ... 160 g/m³
Wet bulb temperature	0 ... +60 °C

With HMP363, HMP364, HMP365, HMP367 and HMP368 Probes

Table 12 HMP363, HMP364, HMP365, HMP367& HMP368 Probes Calculated Variables Specifications

Property	Description / Value
Dewpoint temperature	-40 ... +100 °C
Mixing ratio	0 ... 500 g/kg d.a.
Absolute humidity	0 ... 600 g/m³
Wet bulb temperature	0 ... +100 °C

Outputs

Table 13 Output Specifications

Property	Description / Value
Two analog outputs (one standard, one optional)	two wire 4 ... 20 mA
Typical accuracy of analog outputs at +20 °C	± 0.05 %/°C full scale
Typical temperature dependence of analog outputs	± 0.005 %/°C full scale
RS232C serial output **for service use only in safe area**	connector type RJ45

WARNING Output connections are made via safety barriers.

General

Table 14 General Specifications

Property	Description / Value
Operating voltage with serial port (service mode)	12 ... 28 V 15 ... 28 V
Connections	screw terminals, 0.33 ... 2.0 mm^2 wires (AWG 14-22)
Cable bushings	M20×1.5 (7.5 ... 12 mm) M20×1.5 (10.5 ... 15 mm)
Conduit fitting	M20×1.5 / NPT 1/2"
Operating temperature range for electronics with display Storage temperature range	-40 ... +60 °C -20 ... +60 °C -40 ... +70 °C
Housing material	G-AlSi 10 Mg (DIN 1725)
Housing classification	IP 66 (NEMA 4X)
Housing dimensions	164 × 115 × 62 mm
Housing weight	950 g
Probe material	Stainless steel (AISI 316L)
Fully electromagnetically compatible according to standards	EN 61326-1: Electrical equipment for measurement, control and laboratory use - EMC requirements; Industrial environment

NOTE IEC 1000-4-5 complies only when using external EXi approved surge arrester on safe area.

Classification with Current Outputs

Europe (VTT)

EU (94/9/EC)	II 1 G Ex ia IIC T4 Ga VTT 09 ATEX 028 X
Safety factors	U_i = 28 V, I_i = 100 mA, P_i = 700 mW C_i = 1 nF, L_i negligibly low
Environmental specifications	T_{amb} = -40 ... +60 °C
Dust classification (with protection cover 214101)	II 1 D Ex ta IIIC T_{500} 80 °C Da -40 °C ≤ T_{amb} ≤ +60 °C VTT 04 ATEX 023X

IECEx (VTT)

	Ex ia IIC T4 Ga IECEx VTT 09.0002X
Safety factors	U_i = 28 V, I_i = 100 mA, P_i = 700 mW C_i = 1 nF, L_i negligibly low
Environmental specifications	T_{amb} = -40 ... +60 °C
Dust classification (with protection cover 214101)	Ex ta IIIC T_{500} 80 °C Da IECEx VTT 12.0016X

USA (FM)

	Classes I, II, III Division 1, Groups A - G Division 2, Groups A - D, F and G FM Project ID: 3010615
Safety factors	V_{max} = 28 VDC, I_{max} = 100 mA C_i = 1 nF, L_i = 0, P_i = 0.7 W T_{amb} = 60 °C (140 °F), T5

Japan (TIIS)

	Ex ia IIC T4 Code number: TC17897
Safety factors	U_i = 28 VDC, I_i = 100 mA, C_i = 1 nF P_i = 0.7 W, L_i = 0, T_{amb} = 60 °C (140 °F)

Canada (CSA)

Class I	Division 1 and Division 2 Groups A, B, C, D
Class II	Division 1 and Division 2 Groups G and Coal Dust
Class III	CSA File No: 213862 0 000 CSA report: 1300863
Safety factors	T_{amb} = 60 °C, T4, Intrinsically safe when connected as per Installation Drawing DRW213478

China (PCEC)

Ex ia II CT4
Certificate No. CE092145
Standard GB3836.1-2000 and GB3836.4-2000

Russia (GOST)

1Ex ia IIC T4
Certificate No. ROSS FI.GB05.V03489

Safety factors	U_i = 28 V, I_i = 100 mA, P_i = 700 mW, C_i = 1 nF, L_i = 0 H, T_{amb} = -40 ... +60 °C

Options and Accessories

Table 15 Options and Accessories

Item	Description / Order Code
SENSORS	
HUMICAP®180	15778HM
HUMICAP®180R	HUMICAP180R
HUMICAP®180L2	HUMICAP180L2
FILTERS	
Sintered Stainless Steel Filter	HM47280SP
Stainless Steel Filter	HM47453SP
Stainless Steel Filter with Membrane	214848SP
PPS Plastic Grid with Stainless Steel Netting	DRW010281SP
PPS Plastic Grid Filter	DRW010276SP
TRANSMITTER MOUNTING ACCESSORIES	
Wall Mounting Kit	HM37108SP
Rain shield	215109
Protection cover (for use in the presence of combustible dust, ATEX)	214101
PROBE MOUNTING ACCESSORIES	
HMT363/HMP363	
Duct Installation Kit	210697
Cable Gland M20×1.5 with Split Seal	HMP247CG
Swagelok for 12mm Probe 3/8" ISO Thread	SWG12ISO38
Swagelok for 12mm Probe 1/2" NPT Thread	SWG12NPT12
HMT364/HMP364	
Fitting Body M22×1.5	17223SP
Fitting Body NPT1/2	17225SP
HMT365/HMP365	
Mounting Flange	210696
Cable Gland M20×1.5 with Split Seal	HMP247CG
HMT367/HMP367	
Duct Installation Kit	210697
Cable Gland M20x1.5 with Split Seal	HMP247CG
Swagelok for 12mm Probe 3/8" ISO Thread	SWG12ISO38

Table 15 Options and Accessories (Continued)

Item	Description / Order Code
Swagelok for 12mm Probe 1/2" NPT Thread	SWG12NPT12
HMT368/HMP368	
Fitting Body ISO1/2 Solid Structure	DRW212076SP
Fitting Body NPT1/2 Solid Structure	NPTFITBODASP
Fitting Body Set ISO 1/2	ISOFITBODASP
Fitting Body Set (ISO 1/2 + NPT 1/2)	THREADSETASP
Leaking Screw with Allen Key	216027
Thread Adapter ISO1/2 to NPT1/2	210662SP
Sampling Cell with Female Connectors	DMT242SC
Sampling Cell with Swagelok Connectors	DMT242SC2
Ball Valve ISO1/2 with Welding Joint	BALLVALVE-1
Installation Flange ISO1/2	DM240FA
Manual Press	HM36854SP
CONNECTION CABLES	
Serial Interface Cable	25905ZZ
CABLE BUSHINGS	
Cable Gland M20×1.5 for 7.5...12mm Cable	216587SP
Cable Gland M20×1.5 for 10...15mm Cable	216588SP
Conduit Fitting M20×1.5 for NPT1/2 Conduit	214780SP
Dummy Plug M20×1.5 for transmitter body	214672SP
OTHER	
Calibration Adapter for HMK15	211302SP
Galvanic isolator	212483
Barrier	210664

Accuracy of Calculated Variables

Accuracy of the calculated variables depend on the calibration accuracy of the humidity and temperature sensors; here the accuracy are given for ±2 %RH and ±0.2 °C.

Accuracy of Dewpoint Temperature °C

	Relative humidity									
Temp.	10	20	30	40	50	60	70	80	90	100
-40	1.86	1.03	0.76	0.63	0.55	0.5	0.46	0.43	—	—
-20	2.18	1.19	0.88	0.72	0.62	0.56	0.51	0.48	—	—
0	2.51	1.37	1	0.81	0.7	0.63	0.57	0.53	0.5	0.48
20	2.87	1.56	1.13	0.92	0.79	0.7	0.64	0.59	0.55	0.53
40	3.24	1.76	1.27	1.03	0.88	0.78	0.71	0.65	0.61	0.58
60	3.6	1.96	1.42	1.14	0.97	0.86	0.78	0.72	0.67	0.64
80	4.01	2.18	1.58	1.27	1.08	0.95	0.86	0.79	0.74	0.7
100	4.42	2.41	1.74	1.4	1.19	1.05	0.95	0.87	0.81	0.76
120	4.86	2.66	1.92	1.54	1.31	1.16	1.04	0.96	0.89	0.84
140	5.31	2.91	2.1	1.69	1.44	1.26	1.14	1.05	0.97	0.91
160	5.8	3.18	2.3	1.85	1.57	1.38	1.24	1.14	1.06	0.99

Accuracy of Mixing Ratio g/kg

(Ambient pressure 1013 mbar)

	Relative humidity									
Temp.	10	20	30	40	50	60	70	80	90	100
-40	0.003	0.003	0.003	0.003	0.003	0.004	0.004	0.004	—	—
-20	0.017	0.018	0.019	0.021	0.022	0.023	0.025	0.026	—	—
0	0.08	0.09	0.09	0.1	0.1	0.11	0.11	0.12	0.13	0.13
20	0.31	0.33	0.35	0.37	0.39	0.41	0.43	0.45	0.47	0.49
40	0.97	1.03	1.1	1.17	1.24	1.31	1.38	1.46	1.54	1.62
60	2.68	2.91	3.16	3.43	3.72	4.04	4.38	4.75	5.15	5.58
80	6.73	7.73	8.92	10.34	12.05	14.14	16.71	19.92	24.01	29.29
100	16.26	21.34	28.89	40.75	60.86	98.85	183.66	438.56	—	—
120	40.83	74.66	172.36	—	—	—	—	—	—	—

Accuracy of Wet Bulb Temperature °C

	Relative humidity									
Temp.	10	20	30	40	50	60	70	80	90	100
-40	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	—	—
-20	0.21	0.21	0.22	0.22	0.22	0.22	0.23	0.23	—	—
0	0.27	0.28	0.28	0.29	0.29	0.29	0.3	0.3	0.31	0.31
20	0.45	0.45	0.45	0.44	0.44	0.44	0.43	0.43	0.42	0.42
40	0.84	0.77	0.72	0.67	0.64	0.61	0.58	0.56	0.54	0.52
60	1.45	1.2	1.03	0.91	0.83	0.76	0.71	0.67	0.63	0.6
80	2.23	1.64	1.32	1.13	0.99	0.89	0.82	0.76	0.72	0.68
100	3.06	2.04	1.58	1.31	1.14	1.01	0.92	0.85	0.8	0.75
120	3.85	2.4	1.81	1.48	1.28	1.13	1.03	0.95	0.88	0.83
140	4.57	2.73	2.03	1.65	1.41	1.25	1.13	1.04	0.97	0.91
160	5.25	3.06	2.25	1.82	1.55	1.37	1.24	1.13	1.05	0.99

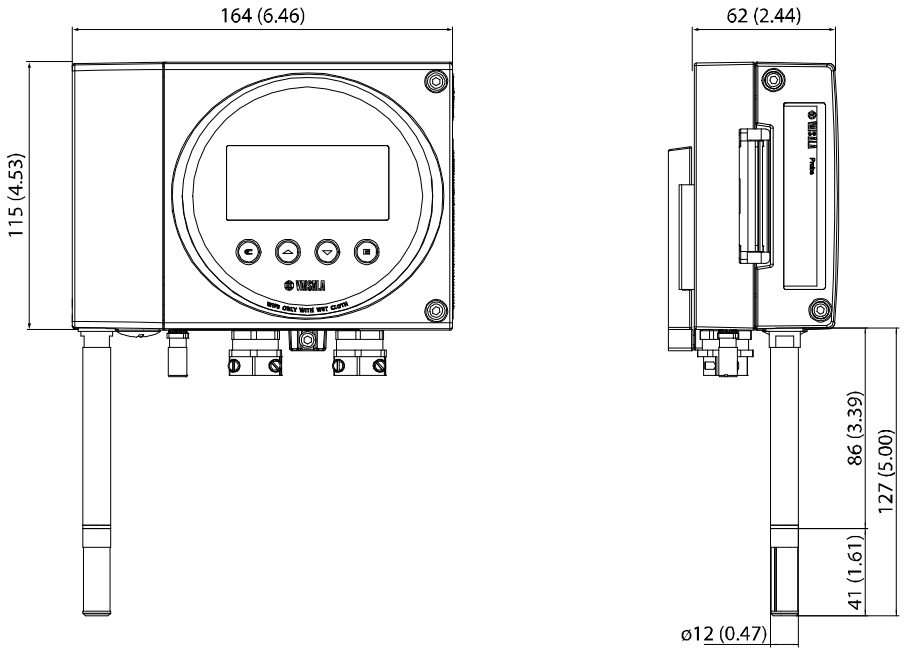
Accuracy of Absolute Humidity g/m^3

	Relative humidity									
Temp.	10	20	30	40	50	60	70	80	90	100
-40	0.004	0.004	0.005	0.005	0.005	0.006	0.006	0.006	—	—
-20	0.023	0.025	0.027	0.029	0.031	0.032	0.034	0.036	—	—
0	0.1	0.11	0.12	0.13	0.13	0.14	0.15	0.15	0.16	0.17
20	0.37	0.39	0.41	0.43	0.45	0.47	0.49	0.51	0.53	0.55
40	1.08	1.13	1.18	1.24	1.29	1.34	1.39	1.44	1.49	1.54
60	2.73	2.84	2.95	3.07	3.18	3.29	3.4	3.52	3.63	3.74
80	6.08	6.3	6.51	6.73	6.95	7.17	7.39	7.61	7.83	8.05
100	12.2	12.6	13	13.4	13.8	14.2	14.6	15	15.3	15.7
120	22.6	23.3	23.9	24.6	25.2	25.8	26.5	27.1	27.8	28.4
140	39.1	40	41	42	43	44	45	45.9	46.9	47.9
160	63.5	64.9	66.4	67.8	69.2	70.7	72.1	73.5	74.9	76.4

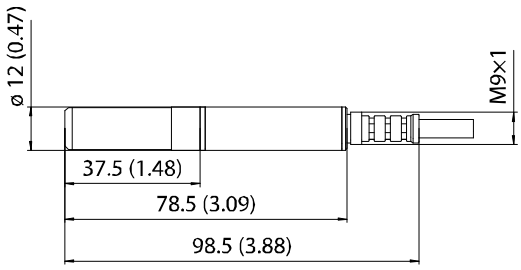
APPENDIX A
DIMENSIONS

This Appendix contains parts drawings of the transmitter housing, probes and some transmitter mounting accessories with metric and nonmetric dimensions specified.

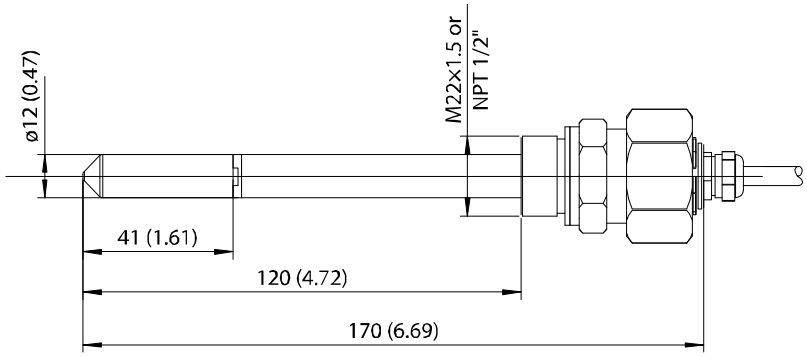
HMP361



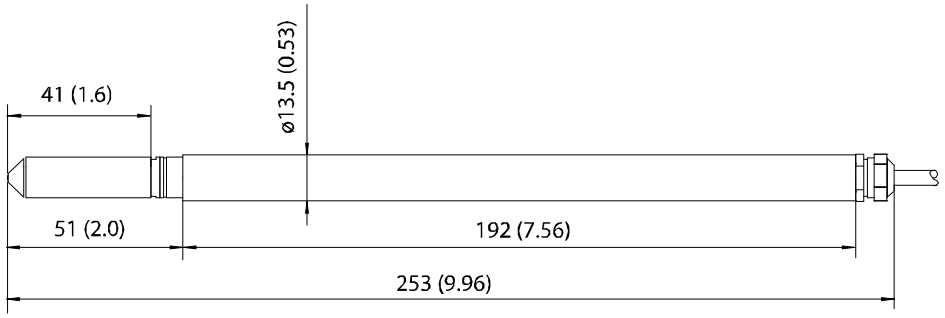
HMP363



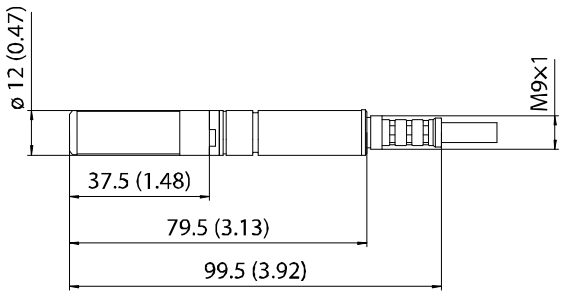
HMP364



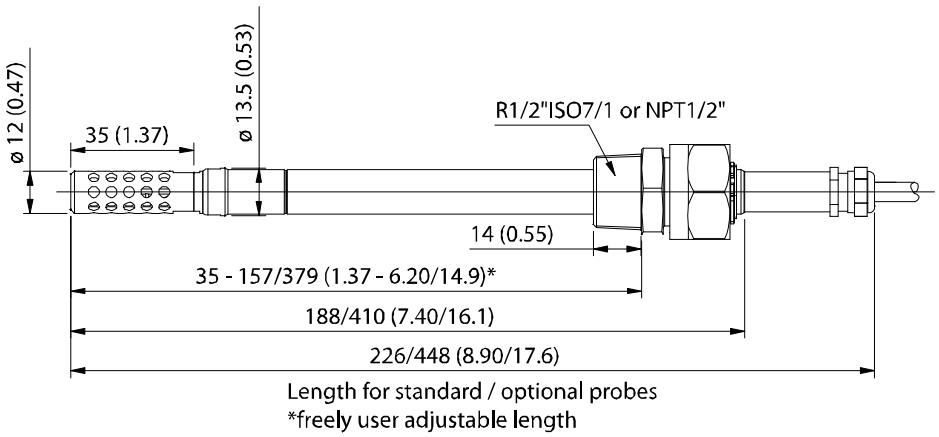
HMP365



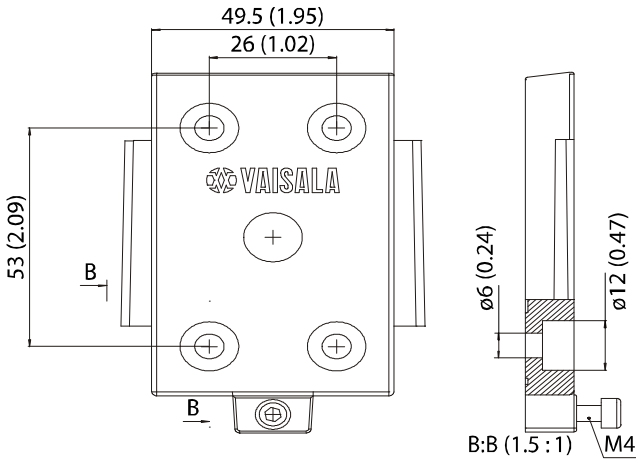
HMP367



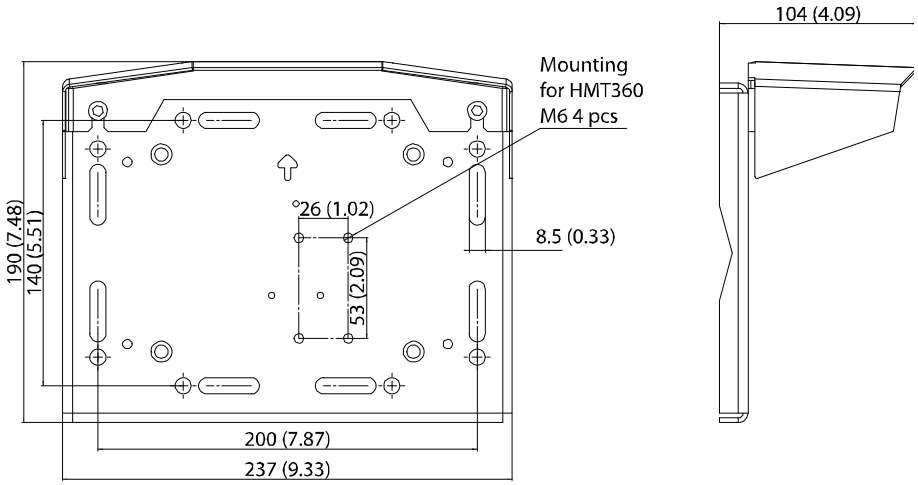
HMP368



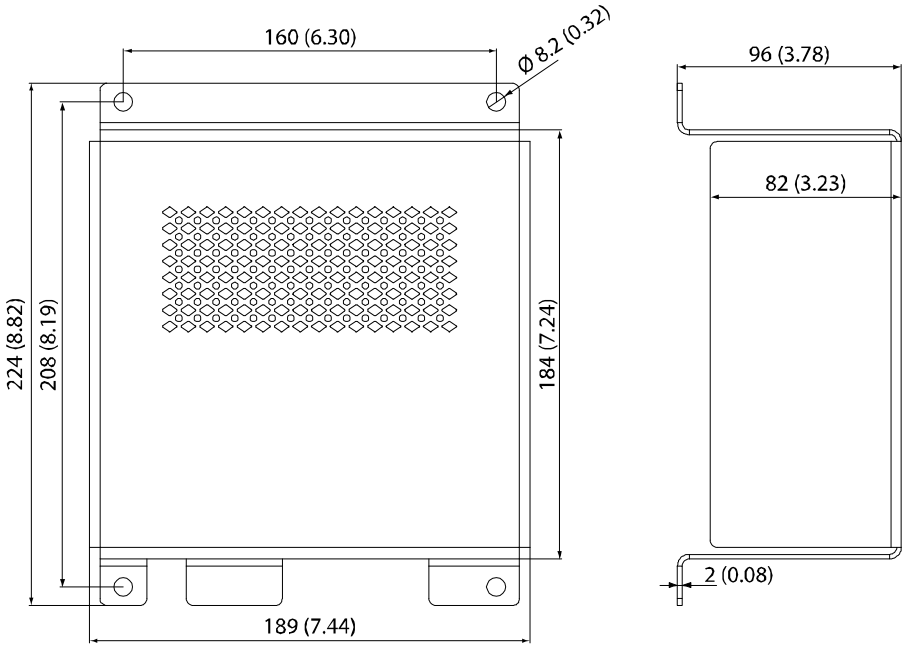
Mounting Plate



Rain Shield



Protection Cover



APPENDIX B

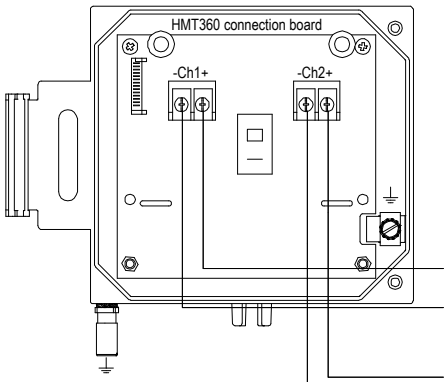
WIRING FOR INTRINSICALLY SAFE OPERATION, FM

This appendix contains the wiring diagram for intrinsically safe operation approved by Factory Mutual (FM).

REV	QTY	DESCRIPTION / INFO / ECO No.		DESIGN	CHECKED / Reviewed	ACCEPTED / Approved
B		List of approved probe types added	ECO212870	RHA	RHA 06-04-24	HJJ 06-05-04

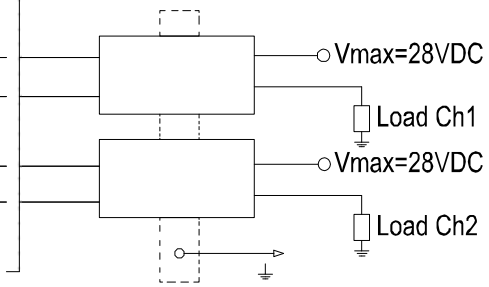
Wiring diagram for intrinsically safe operation of the HMT360-series humidity and temperature transmitter.

HAZARDOUS AREA



SAFE AREA

Use FM approved associated apparatus; zener barriers or galvanic separators with entity concept parameters:
Voc < 28V
Isc < 100mA
Ca > Ci + Ccable
La > Li + Lcable



HMT360 transmitter series has following approved probe options:

HMP361, HMP362, HMP363, HMP364, HMP365, HMP367 & HMP368

HMT360-series transmitters are approved for use in Classes I, II and III, Division 1, Groups A - G and Division 2, Groups A - D, F and G.

Safety factors for HMT360-series transmitters are: Vmax=28V, Imax=100mA, Ci=1nF, Li=0, Pi=0.7W

NOTE:
1. Barrier installation must be completed in accordance with ANSI/ISA RP 12.6 and the National Electrical Code.
2. Intrinsically safe barrier ground must be less than 1 ohm.
3. Maximum safe area voltage is 250V.

General tolerance ISO 2768-m		Design		VAISALA	
Material	Weight	Supplier code		Title	Assembly Instruction HMP360 and HMT360 VIN/HM
Finish		DOCUMENT CREATION DATA YYYY-MM-DD	INITIALS		
		Creator	01-07-18 ARH		
		Review	01-11-19 ARH	Size	Code DRW211603 Rev B
FIRST ANGLE PROJECTION	DIMENSIONS ARE IN MILLIMETERS, UNLESS OTHERWISE SPECIFIED	Approved	05-04-11 RHA		
		Archive ID	ACAD	Scale	Sheet of

APPENDIX C

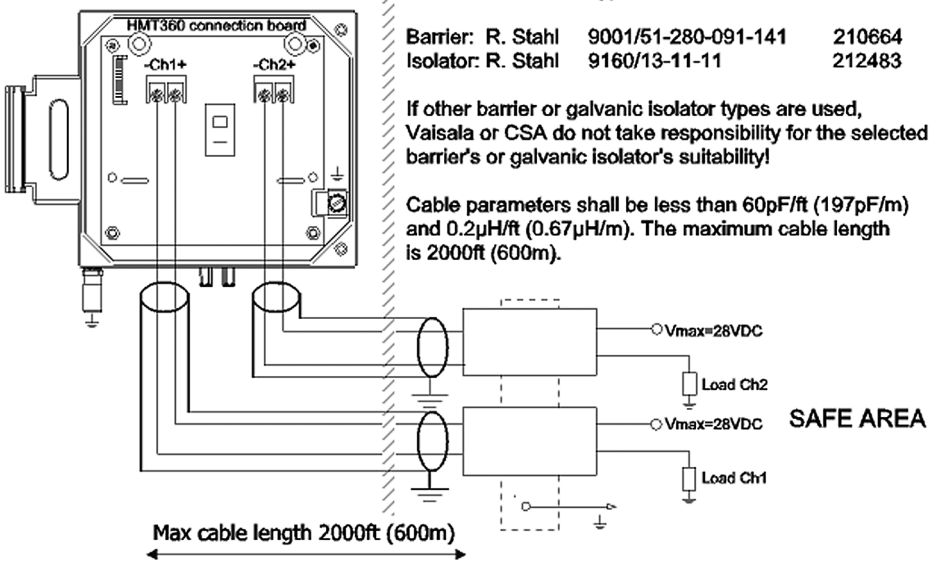
WIRING FOR INTRINSICALLY SAFE OPERATION, CSA

This appendix contains the wiring diagram for intrinsically safe operation approved by the Canadian Standards Association (CSA).

Ltr	Qty	Change	Reason/ InDO no	Design	Date Review	Date Appr
C		Probe types and barrier/isolator info updated	ECO212844	KKe	2006-06-20 RHA	2006-06-20 HJJ

Wiring diagram for intrinsically safe operation of the HMT360-series humidity and temperature transmitter.

HAZARDOUS AREA



Vaisala offers following barrier and galvanic isolator types:

Manufacturer:	Type:	Vaisala code:
Barrier: R. Stahl	9001/51-280-091-141	210664
Isolator: R. Stahl	9160/13-11-11	212483

If other barrier or galvanic isolator types are used, Vaisala or CSA do not take responsibility for the selected barrier's or galvanic isolator's suitability!

Cable parameters shall be less than 60pF/ft (197pF/m) and 0.2µH/ft (0.67µH/m). The maximum cable length is 2000ft (600m).

HMT360-series transmitters are approved for use in Division 1 and 2, Class I, Groups A, B, C, and D.
Division 1, and 2, Class II, Group G and coal dust.
Division 1, and 2, Class III.

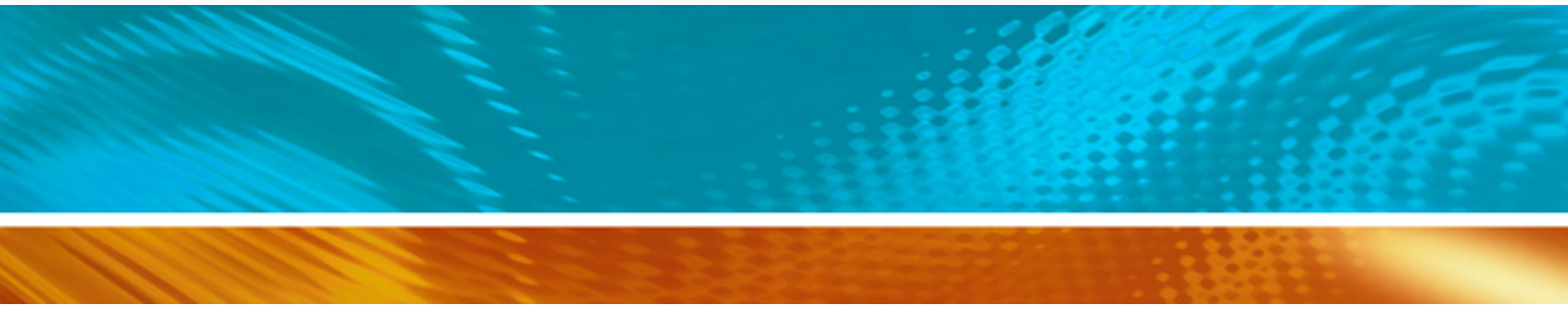
NOTE:
1. Each channel must be supplied through separate shielded cables.
2. When using galvanic separators CH1- and CH2- must be short circuited with an external wire.
3. When using transmitter in Class I, Division 2 the main switch shall not be operated or the unit shall not be disconnected unless power has been switched off, or area is known to be non hazardous.
4. Use only conduit connection in Division 2.
5. Substitution on components may impair intrinsic safety or suitability for Division 2.
6. Only intrinsically safe installation is allowed in Class II and Class III environments.
7. Intrinsically safe barrier ground must be less than 1 ohm.
8. Maximum safe area voltage is 250V.

HMT360-series transmitters shall be used with following probes:
Probe HMP361 with 127mm long pipe.
Probe HMP362 with 2, 5 or 10 m length cable
Probe HMP363 with 2, 5 or 10 m length cable
Probe HMP364 with 2, 5 or 10 m length cable
Probe HMP365 with 2, 5 or 10 m length cable
Probe HMP367 with 2, 5 or 10 m length cable
Probe HMP368 with 2, 5 or 10 m length cable

The material for associated cable is FEP (Tetrafluoropropylene) or for HMP363 also PUR (Polyurethane) available.

To avoid static discharge shall the cable cover with conductive material.

Drawn KKe 2002-08-21	Arch id	Serial no	Sheet	Cooperation's doc no
Reviewer IML 2002-10-06	Title: **Installation Drawing**	Vaisala Oyj Vanhanurmijärventie 21 Vantaa Finland		VAISALA
Appr KKe 2002-10-06				
Design	Scale		Dwg no DRW213478	Rev C
Replaces DRW213478B				
Replaced by				



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